A prospective study of

EARLY FUNCTIONAL OUTCOME OF ANTERIOR CRUCIATE LIGAMENT INJURIES MANAGED BY ARTHROSCOPIC FOUR STRAND HAMSTRING AUTOGRAFT

Dissertation submitted to

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Award of the degree of

M.S. (ORTHOPAEDIC SURGERY)
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CERTIFICATE

This is to certify that **Dr.B.VIJAYAN,** post graduate student (2008-2011) in the Department of Orthopedic Surgery**, Kilpauk Medical College & Government Royapettah Hospital ,** has done dissertation on **''EARLY FUNCTIONAL OUTCOME OF ANTERIOR CRUCIATE LIGAMENT INJURIES MANAGED BY ARTHROSCOPIC FOUR STRAND HAMSTRING AUTOGRAFT''** under my guidance and supervision in partial fulfillment of the regulation laid down by the **'THE TAMILNADU DR MGR MEDICAL UNIVERSITY, CHENNAI 32'** for M.S.(Orthopaedic Surgery) degree examination to be held in April 2011.

Dean
Kilpauk Medical College and Hospital
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I wish to express my thanks to anesthesiologists, postgraduate colleagues, staff members, and theatre staff for the help they have rendered. Finally I thank all **my patients** who gave full cooperation for this study.

DECLARATION

I , **Dr. B.VIJAYAN**, solemnly, declare that Dissertation titled ‘‘**EARLY FUNCTIONAL OUTCOME OF ANTERIOR CRUCIATE LIGAMENT INJURIES MANAGED BY ARTHROSCOPIC FOUR STRAND HAMSTRING AUTOGRAFT’’** is a Bonafide work done by me at Government Royapettah Hospital & Kilpauk Medical College between 2008 to 2010, under the guidance and supervision of our Head of the Department and my Unit Chief , **Prof.K.V. CHANDRASEKARAN M.S. (Ortho), D.Ortho.**

This dissertation is submitted to “**THE TAMILNADU DR MGR MEDICAL UNIVERSITY”**, towards partial fulfillment of regulations for the award of M.S.DEGREE BRANCH II in Orthopaedic Surgery.

Place: Chennai

Date: **(DR.B.VIJAYAN)**

CONTENTS

Introduction

INTRODUCTION

ACL reconstruction is one of the most common procedures being performed with an estimated 100,000 surgical reconstructions performed annually in United States [1]. During the last 25 years, ACL has been one of the most studied structures in the musculoskeletal system[2].In recent times awareness of the ACL injuries are far reaching and people of all walks of life seek treatment for ACL deficiency .Indeed, most of our patients are from in and around Chennai with awareness and willingness towards ACL Reconstruction.

Fate of ACL deficient knee is studied in detail by Donald c. Fithian and 'ACL injury cascade' proposed by Daniel et al[3] as

The ACL Injury Cascade

ACL Disruption

⇩

Subluxation ⟹ Giving Way

⇩

Meniscus Injury ⟹ Sports Disability

⇩

Joint Arthrosis

And in effect produced increased incidence of premature OA of the knee;

One another compelling reason for ACL Reconstruction is by Anderson et al[3] study which showed that early ACL reconstruction lowered secondary Meniscal tear rate from 27% to 3%.With recent advances in arthroscopic instrumentation and surgical techniques in incorporating autologous graft and also with advances in both graft fixation and rehabilitation has made the olden days of ACL deficiency damaging a person's knee and his career gone for sure.

The current concept of ACL reconstruction is Transportal anatomic ACL reconstruction .However there is a new found interest in some centers doing double bundle reconstruction, particularly in sports personnel which is much more technically demanding and with technical advancement in computer-assisted navigation and fluoroscopic placement of tunnels, results have improved in a great way. As J. C. Imbert, suggest it is likely that ligament replacements will take the form of "bio-implants" produced with the aid of cell and tissue culture techniques. Perhaps, fresh lesions could be made to heal with gene therapy. Research along these lines is currently being conducted at Pittsburgh, US (F. Fu).

In our prospective study of 20 cases we have undertaken ACL Reconstruction with the four strand HAMSTRING graft through arthroscopy and assessed its functional outcome using Lysholm knee score[4] & IKDC subjective knee evaluation score.

Aim of the study

AIM OF THE STUDY

The aim of this study is to assess ‘‘**THE EARLY FUNCTIONAL OUTCOME OF ANTERIOR CRUCIATE LIGAMENT INJURIES MANAGED BY ARTHROSCOPIC FOUR STRAND HAMSTRING AUTOGRAFT’’** at Government Royapettah Hospital & Kilpauk Medical College, Chennai from NOVEMBER 2008 to AUGUST 2010.

Review of literature

REVIEW OF LITERATURE

HISTORICAL REVIEW

One of the first anatomical descriptions is found in Egyptian Papyrus Scroll[2] dating back to as early as 3000 B.C. Hippocratus[2] (460-370 B.C) described subluxation of knee in relation to ACL. Claudius Galen[2] (129 B.C) was the first one to name it "ligmenta genu cruciate" and was the first to describe ACL as a supporting structure to the diarthrodial joint and emphasized its role as a joint stabilizer and in restricting abnormal motion. Mayo Robson was the first man to repair ACL in the year 1895, by direct suturing[5].

Hey Groves[6, 7] in 1917 reconstructed ACL, using a proximally based strip of iliotibial band, intraarticularly through femoral and tibial tunnels. This formed the basis of modern technique of intraarticular cruciate ligament reconstruction. Alwyn Smith[8] augmented this technique by reinforcing the medial side.

In the period 1920 to 1930, extraarticular stabilization of ACL deficient knee gained popularity. Bennett[9] in 1926 described an extraarticular procedure of medial capsular plication and reinforcement with fascia. Mauck[10] in 1936, described an extraarticular procedure, he advanced the bony tibial attachment of medial collateral ligament distally.

1930s to 1940s saw the resurgence of intraarticular reconstruction of ACL. In 1936, Campbell[11] used a distally based graft formed by the medial portion of the patellar tendon, capsule and quadriceps tendon routed through femoral and tibial tunnels. Semitendinosus tendon graft was used for intraarticular reconstruction by Macey[12] in 1939.

1950s to 1960s: This period formed the basis for modern ACL reconstruction. In 1956 Augustine[13] described dynamic ACL reconstruction by routing semitendinosus tendon through back of the knee joint, forward through a tibial tunnel. He also emphasized on vigorous muscle strengthening. O' Donoghue[14] in 1950 described about the "Unhappy triad" which includes rupture of ACL, medial collateral ligament and tear of the medial meniscus. He also emphasized about Hey groves technique.

Jones[15] in 1963 used the central third of patellar tendon with an attached patella bone block to reconstruct ACL. Lam[16] in 1968 modified this procedure, by placing the graft in a more anatomical position. 1970s was the period during which instability tests and classification was introduced. Galway[17] in 1972 described about pivot shift sign. Slocum, Larson and Losee et al [18] described the variation of pivot shift test.

Hughston et al[19] in 1976 presented standardized terminology and a classification system for knee ligament instabilities. The lachman test was

described by Torg et al[20]. In 1976 Franke[21] used the patellar tendon with bone from tibia and patella as a free graft . Mcmaster and Thompson et al[21] described a reconstructive procedure using the gracilis. Ellison[22] in 1979 described a dynamic transfer of iliotibial band, passed underneath the lateral collateral ligament.

Late 1980's saw the emergence of prosthetic ligaments. In 1983, Rushton[23] used carbon fibre ligament to augment reconstruction. Rodkey, Rubin and Paddu[24], tested Dacron as a cruciate ligament substitute in 1987. Bolton and Brickman[25] developed polytetrafluroethylene (Gore-Tex) prosthetic ACL. In 1988, M. J. Friedman[11] pioneered the use of an arthroscopically assisted four-stranded hamstring autograft technique. He was followed, in 1993 (after the 1992 AAOS Annual Meeting in Boston), by R. L. Larson, S. M. Howell[16], Tom Rosenberg[26] (US), and Leo Pinczewski[27] (Sydney) and they used the pes tendons (semitendinosus and gracilis) in three or four strands, with graft placement in a femoral socket. Pinczewski used an "all-inside" technique, with a special large (8 mm) round-headed interference screw, known as the RCI screw. Other leading-edge groups started using hamstring tendons, with different means of fixation. Tom Rosenberg devised fixation with the so-called Endo-Button that locked itself against the lateral aspect of the femoral condyle.

HISTORY ARTHROSCOPY

Medical endoscopies began in the early 1800s by ***Bozzini***. In 1918, **Prof Kenji Takagi**[41] of Tokyo University did the first arthroscopy. It was done in a cadaver knee with a cystoscope.

2010 marks the end of the fourth decade of arthroscopic surgery, although pioneering work in the field began as early as the 1920s with the work of **Dr. Eugene Bircher**[41] who was the first to perform and publish the first arthroscopy on live patients. To begin with, it was used to diagnose tuberculosis, which was more prevalent in those days. Since then the developments in arthroscopy have become many fold Arthroscopic surgery was begun by a Japanese surgeon **Masaki Watanabe, MD**.

Dr. O'Connor and Dr. Shahriaree[41] began experimenting with ways to excise fragments of menisci in the early 1970s. Dr. O'Connor paved the way for arthroscopic surgery and did more to pioneer and develop the techniques of arthroscopic meniscectomy than any other person in North America Together both doctors fashioned the first operating arthroscope and helped to generate and produce the first high-quality color intraarticular photography. **Dr. O'Connor wrote the first book under the title, Arthroscopy**. **Dr. Shahriaree** has written three books on arthroscopic surgery titled "The Arthroscopic Surgery".

SURGICAL ANATOMY

EMBRYOLOGY

The anterior cruciate ligament itself appears as a condensation in the blastoma at about 6.5 weeks[28]. It begins as a ventral ligament and gradually invaginates with the formation of the intercondylar space. It appears well before joint cavitation and remains extrasynovial at all times. **Tena-Arregui et al[29]** performed arthroscopy on the knee of fetuses with a gestational age of 24 to 40 weeks. At these stages two main bundles were already detectable, but the bundles seemed more parallel when compared to the bundle orientation of the adult ACL.

MICROANATOMY

On the ultra structural level, ACL is composed of longitudinally oriented fibrils of mostly Type I collagen tissue ranging from 20 to 170 µm in diameter[28]. Bundles of collagen fibrils makes up subfascicular units, which are surrounded by a thin band of loose connective tissue called the endotenon. Many subfasciculi are grouped together to make a collagen fasciculus. The fasciculus is surrounded by epitenon. Surrounding the entire ligament is the paratenon.

GROSS ANATOMY

The narrowest diameter of ACL occurs in the mid substance. The ACL is about 31 to 35mm in length and 31.3 mm^2 in cross section. The synovial membrane covers the ACL; though intraarticular it is extra synovial. Based on its insertion to the tibia, it is divided into three bundles. i. Anteromedial bundle.

ii. Intermediate bundle

iii. Posterolateral bundle

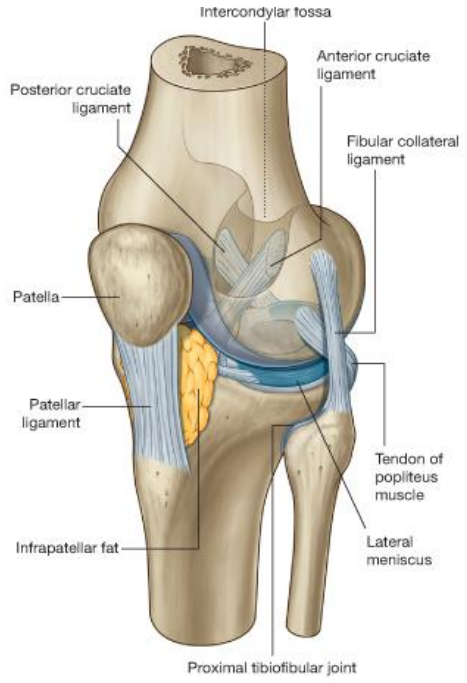
FEMORAL ATTACHMENT

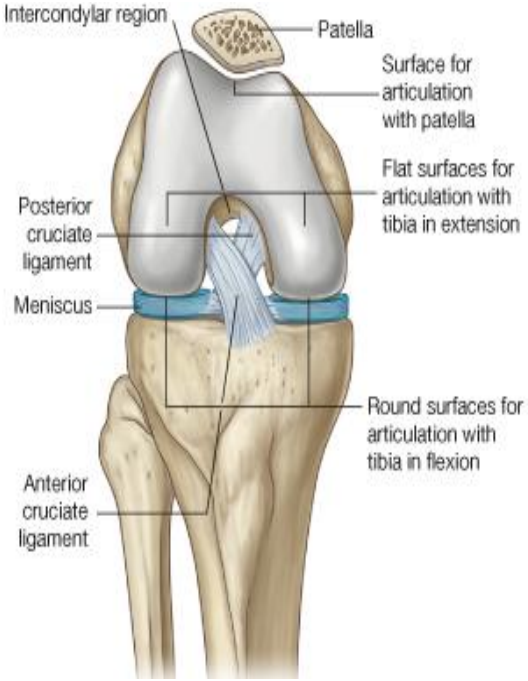
Arise from the posteromedial aspect of the intercondylar notch on the lateral femoral condyle. This is a circular area of 113mm^2 in average, as described by Harner and Co-workers.

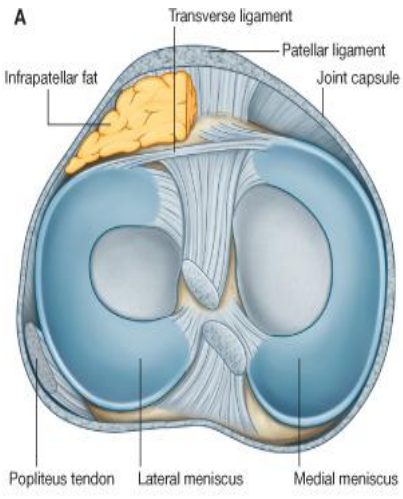
TIBIAL ATTACHMENT

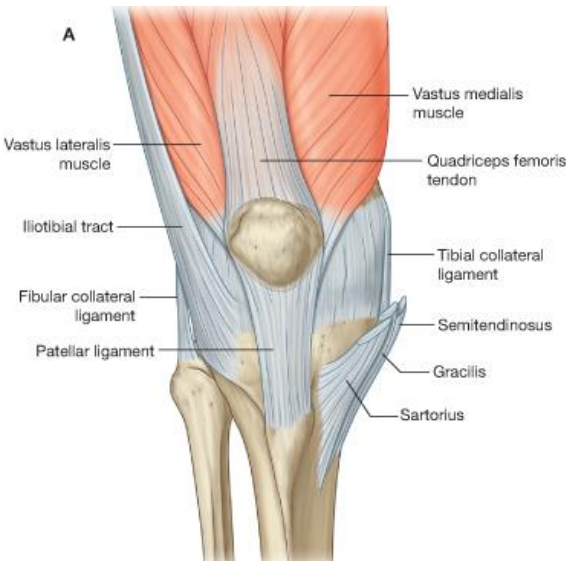
The ACL fibres fans out as they approach their tibial insertion, just medial to the attachment of the anterior horn of lateral meniscus. The insertion site is more oval, with an average area of 136mm^2. Insertion sites of ACL are divided into 4 zones:

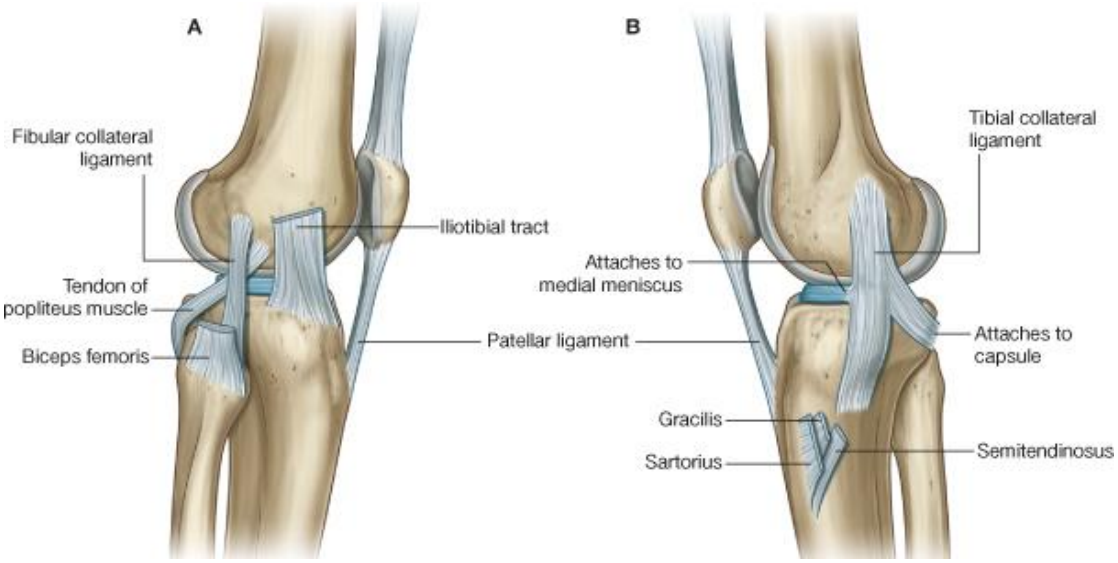
Zone I	-	Ligament tissue (Collagen)
Zone II	-	Collagen blending with fibro cartilage
Zone III	-	Mineralized fibro cartilage
Zone IV	-	Subchondral bone

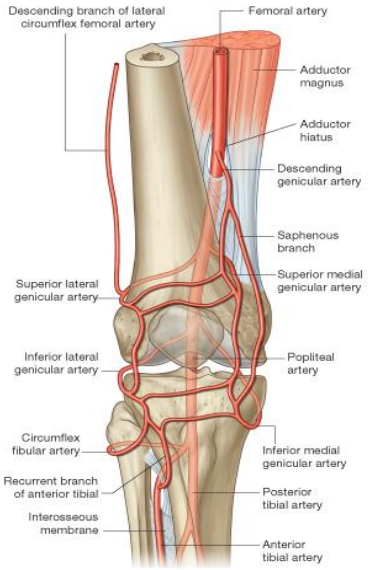

Intercondylar fossa
Anterior cruciate ligament
Posterior cruciate ligament
Fibular collateral ligament
Patella
Patellar ligament
Tendon of popliteus muscle
Lateral meniscus
Infrapatellar fat
Proximal tibiofibular joint

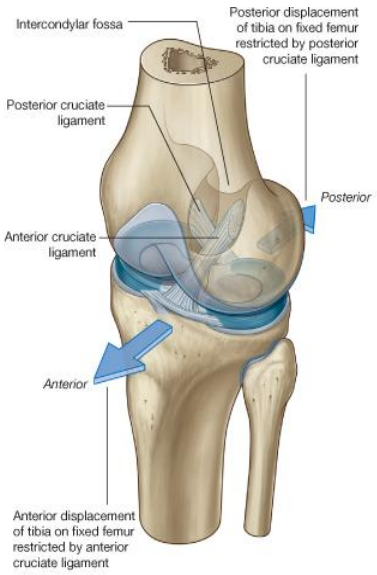

Intercondylar region
Patella
Surface for articulation with patella
Flat surfaces for articulation with tibia in extension
Posterior cruciate ligament
Meniscus
Round surfaces for articulation with tibia in flexion
Anterior cruciate ligament

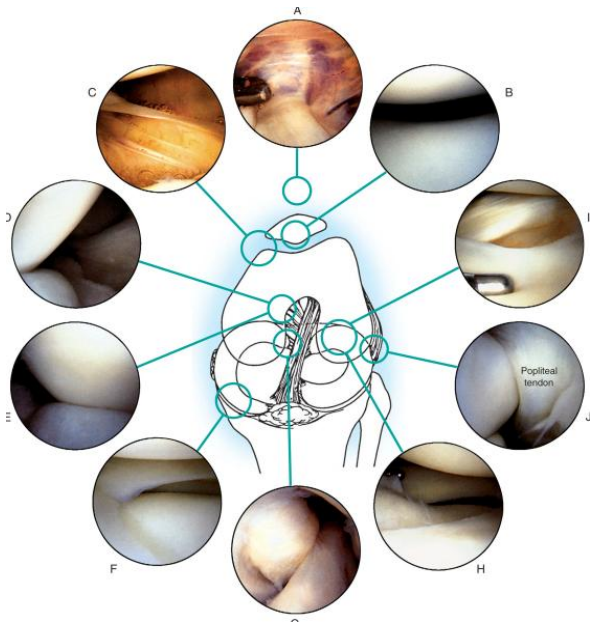

A
Transverse ligament
Patellar ligament
Infrapatellar fat
Joint capsule
Popliteus tendon
Lateral meniscus
Medial meniscus


A
Vastus medialis muscle
Vastus lateralis muscle
Quadriceps femoris tendon
Iliotibial tract
Tibial collateral ligament
Fibular collateral ligament
Semitendinosus
Patellar ligament
Gracilis
Sartorius


A
Fibular collateral ligament
Iliotibial tract
Tendon of popliteus muscle
Biceps femoris
Patellar ligament
B
Tibial collateral ligament
Attaches to medial meniscus
Attaches to capsule
Gracilis
Semitendinosus
Sartorius


Descending branch of lateral circumflex femoral artery
Femoral artery
Adductor magnus
Adductor hiatus
Descending genicular artery
Saphenous branch
Superior medial genicular artery
Superior lateral genicular artery
Inferior lateral genicular artery
Popliteal artery
Circumflex fibular artery
Inferior medial genicular artery
Recurrent branch of anterior tibial
Posterior tibial artery
Interosseous membrane
Anterior tibial artery


Intercondylar fossa
Posterior displacement of tibia on fixed femur restricted by posterior cruciate ligament
Posterior cruciate ligament
Posterior
Anterior cruciate ligament
Anterior
Anterior displacement of tibia on fixed femur restricted by anterior cruciate ligament


A
B
C
F
H
Popliteal tendon

BLOOD SUPPLY

Mainly from the middle genicular artery, this leaves the popliteal artery and directly pierces the posterior capsule. Branches from this artery form a periligamentous plexus within the synovial sheath. Inferior, medial and lateral genicular arteries also contribute through the fat pad.

The osseous attachment of ACL contributes little to its vascularity[30].

NERVE SUPPLY

By a branch of the tibial nerve, the posterior articular nerve.

ARTHROSCOPIC ANATOMY

a) 7mm from the anterior margin of PCL INSERTION is found to be the center of postero-lateral fibers
b) Anterior horn of lateral meniscus described to be the center of antero-medial fibers.

Wolf peterson[31] described these as the two land marks used for tibial tunnel placement in all arthroscopic techniques.

Classification

CLASSIFICATION OF KNEE INSTABILITY

It was developed by **Hughston** and set forth by the American Orthopaedic Society for Sports Medicine[32]. The tibial plateau is divided into four quadrants that serve as the reference points in the definition of knee instability. Knee instability is best classified as straight (non rotatory or one-plane) instability, rotatory (simple or two-plane) instability, or a combined instability.

CLASSIFICATION OF KNEE JOINT INSTABILITY RESULTING FROM LIGAMENT INJURY

I. **One- plane instability (simple or straight)**

- A. One-plane medial
- B. One-plane lateral
- C. One plane posterior
- D. One plane anterior

II **Rotatory Instability**

- A. Anteromedial
- B. Anterolateral
- C. Posterolateral
- D. Posteromedial

III. **Combined Instability**

A. Anterolateral – anteromedial rotatory

B. Anterolateral – Posterolateral rotatory

C. Anteromedial – Posteromedial rotatory

COMBINED INSTABILITIES

Instabilities where there is rotatory instability in one quadrant, rotatory, varus or valgus instability in another quadrant.

There are three combined instabilities they are.

1. Anterolateral – anteromedial rotatory instability – most common
2. Anterolateral – posterolateral rotatory instability.
3. Anteromedial – Posteromedial rotatory instability.

ONE-PLANE INSTABILITY

One Plane Instability	**Disrupted Ligaments**
Medial	Medial collateral ligament, medial capsular ligament, ACL, posterior oblique ligaments, medial portion of the posterior capsule.
Lateral	Lateral capsular ligament, Lateral Collateral ligament, the biceps tendon, iliotibial band, arcuate popliteus complex, the popliteofibular ligament and ACL.
Posterior	PCL, arcuate ligament complex, posterior

	oblique ligament
Anterior	ACL, lateral capsular ligament, medial capsular ligament

ROTARY INSTABILITY

Rotary Instability	**Disrupted Ligaments**
Anteromedial	Medial capsular ligament, the medial collateral ligament, posterior oblique ligament & ACL
Anterolateral	Lateral capsular ligament, the arcuate ligament & ACL
Posteromedial	Posterior oblique ligament, posterior capsule, Medial collateral ligament; Medial capsular ligament and PCL
Posterolateral	Popliteus tendon, the arcuate ligament, the lateral capsular ligament and the PCL.

Bio mechanics &

Mechanism of ACL injury

BIOMECHANICS OF THE KNEE

ACL plays an important role in biomechanics of knee during daily activities by controlling anterior tibial translation, as well as tibial rotation. The major complication of the neglected ACL are instability, secondary meniscal injury and early osteoarthritis according to **Thomas p.andriacchi** results primarily due to shift of load from load bearing areas to unconditioned region of cartilage leading to premature break down and rapid thinning out of cartilage when compared with normal knee and is more pronounced towards medial compartment. The need for normal biomechanics paves way towards understanding the pivotal role of ACL in knee.

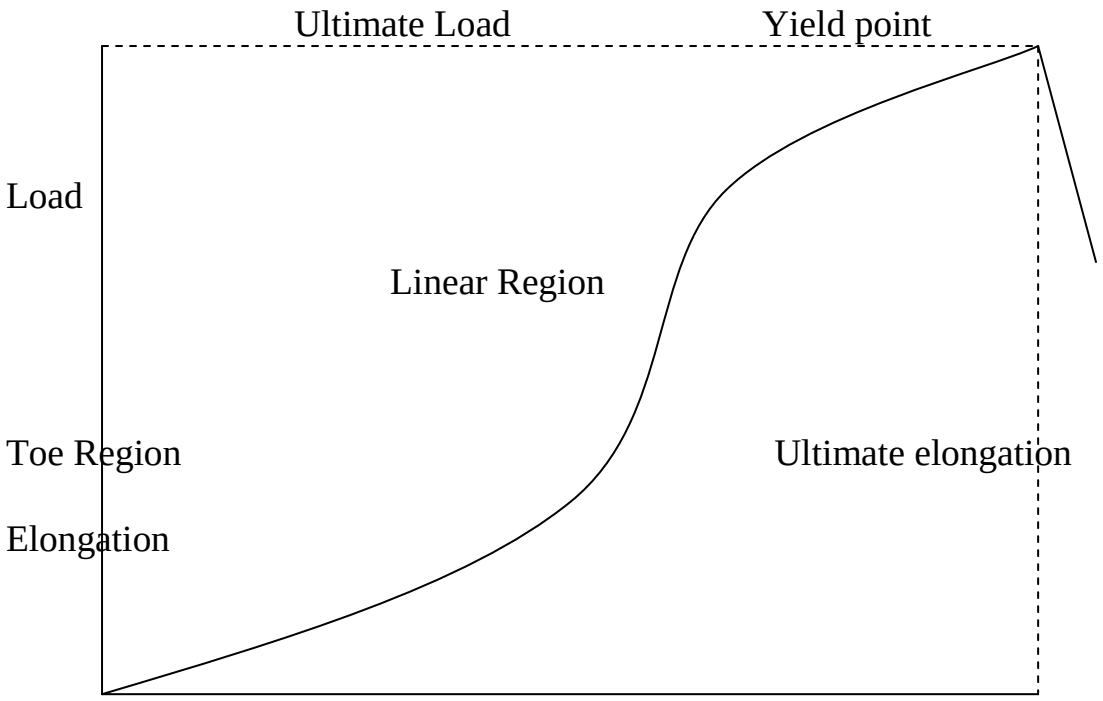
The function and the biomechanics of ACL can be understood only in conjunction with the entire knee joint which comprises of three independent articulations, one between patella and femur and the remaining two between the lateral and medial tibial and femoral condyles.

To study the interaction of the cruciate ligaments with tibiofemoral joint a simplified two-dimensional, single degree of freedom "Crossed four-bar Linkage" moving in a single plane is commonly used. The model consists of two crossed rods that may be considered to be neutral fibres within the two cruciates that remains isometric during passive flexion and

the two connecting bars that represents the line between the femoral (Bluemensaat's line) and tibial attachments. The "gliding" intersection of the crossed bars represents the instant centre of joint rotation. Thus, the intersection between these four bars can be used to describe the motion of both the tibial and femoral condyles as well as the posterior migration of tibio femoral contact points that occur with knee flexion.

STRUCTURAL PROPERTIES OF THE BONE LIGAMENT BONE COMPLEX

This is described by a load-deformation curve.



Initially, little load is required to elongate the ligament. This is characterized by relatively the toe region of the curve. The change from the toe region to the linear portion of the curve represents the change in

stiffness that an examiner perceives during a clinical laxity examination when a ligament's end point is reached. The toe region is followed by a second high stiffness linear region where significantly larger loads are required for continued, elongation, here all collagen fibres are straightened. If loading continues past the yield point, until which maximum plastic deformation has taken place, the ligament ruptures.

MECHANICAL PROPERTIES DURING MUSCLE ACTIVITY

It has been shown that the introduction of muscle activity substantially alters the kinematics of the knee.

QUADRICEPS

The quadriceps muscle forces cause strain in ACL with largest strain occurring between 5° and 40° of knee flexion.

HAMSTRINGS

The hamstrings negate the increased strains in the ACL caused by Quadriceps activity[33].

FUNCTIONS

The ACL holds a key position along with other ligaments in the stability of the knee joint. The function of ligaments as primary and secondary restraint was introduced by **Butle**.

- Primary restraint to the anterior translation of the tibia relative to the femur.

- Secondary restraint to internal rotation in the non weight bearing and weight bearing knee, particularly in full extension.
- Secondary restraint to external rotation and varus-valgus angulation, particularly under weight bearing conditions.

MECHANISM OF ACL INJURY

Typical mechanism of injury is rapid but awkward stop and lateral movements. ACL tears in as short as 70 milliseconds following awkward landing. The exact point of ACL failure is just prior to gross valgus.
ACL injuries are common, secondary to sports injury, RTA, fall etc.

Various forces which lead to ACL rupture are External rotation and abduction with knee at 90° of flexion.

1. Complete dislocation of knee.
2. Direct posterior force against the upper end of the tibia.
3. Internal rotation of tibia, while the knee is extended.

Materials and methods

MATERIALS AND METHODS

This prospective study is an analysis of 20 cases of anterior cruciate ligament injuries treated arthroscopically with anatomic endoscopic four strand hamstring autograft at the Department of Orthopedic surgery, Government Royapettah Hospital and Kilpauk Medical College, Chennai from November 2008 to October 2009 with a minimum follow up of 4 months and a maximal follow up of 22 months. In our study of 20 patients, 19 were males and one was a female (table-1)

TABLE -1

SEX DISTRIBUTION

Sex	**No. of patients**	**Percentage (%)**
Male	19	95
Female	1	5

TABLE- II

AGE DISTRIBUTION

Age group: 19 years to 47 years

Mean age: 29.5 years

Age group of patients	No. Of patients	Percentage	Males	Females
10-20 yrs	1	5%	1	0
21-30 yrs	12	60%	12	0
31-40 yrs	6	30%	5	1
41-50 yrs	1	5%	1	0

TABLE III

MODE OF INJURY

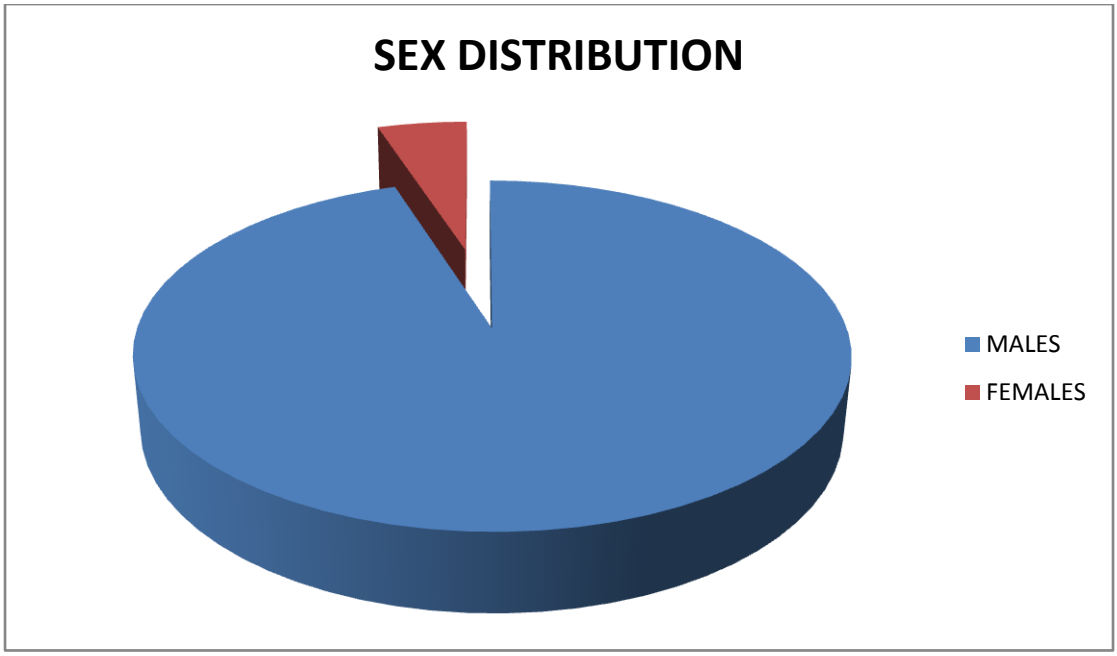
Mode of injury	No. of patients	Percentage
Sports injuries	10	50%
RTA	8	40%
others	2	10%

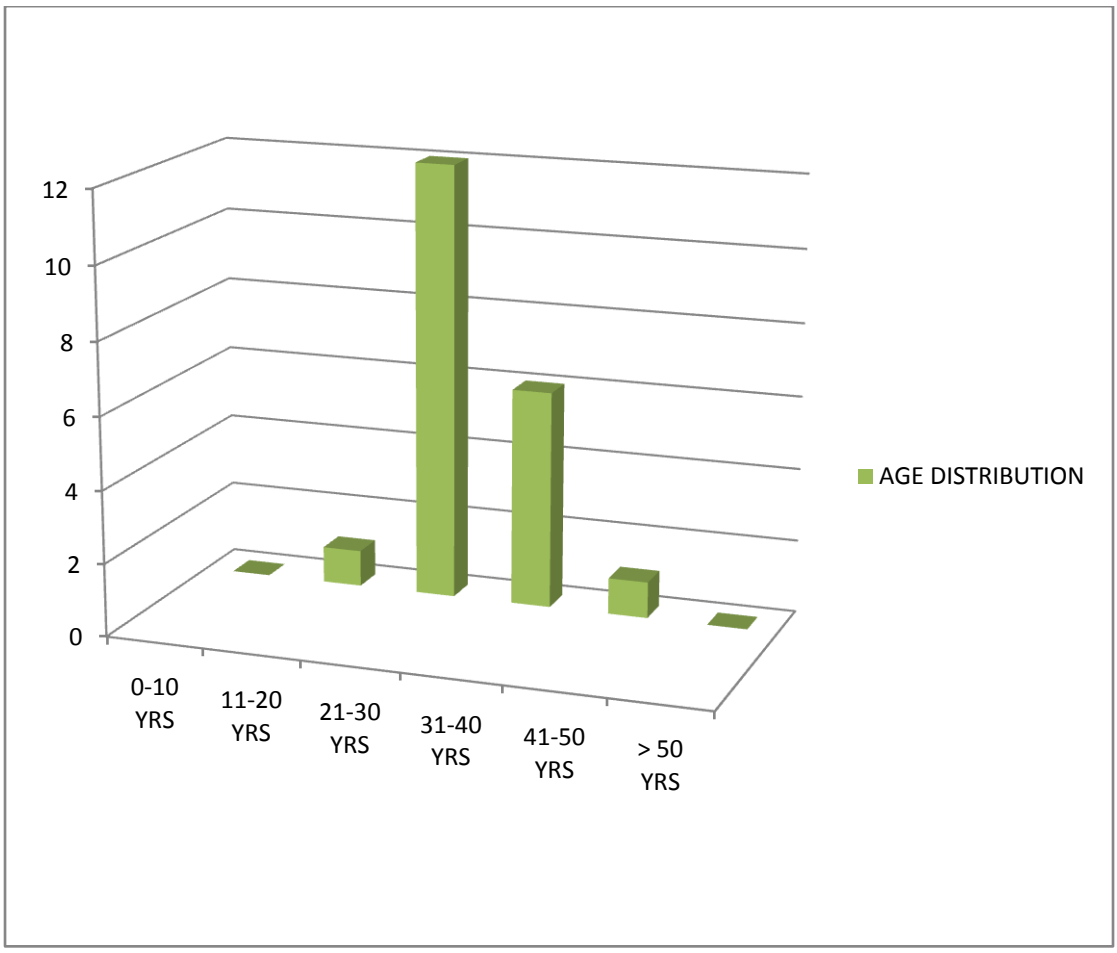
The mode of injury was RTA in 8 cases (40%), sports injuries in 10 cases (50%) and other modes in 2 cases (10%).

TABLE IV

SIDE OF INJURY

Side	No. of patients	Percentage
Right knee	13	65%
Left knee	7	35%


SEX DISTRIBUTION
MALES
FEMALES


12
10
8
6
4
2
0
0-10 YRS
11-20 YRS
21-30 YRS
31-40 YRS
41-50 YRS
> 50 YRS
AGE DISTRIBUTION

MODE OF INJURY

SIDE OF INJURY

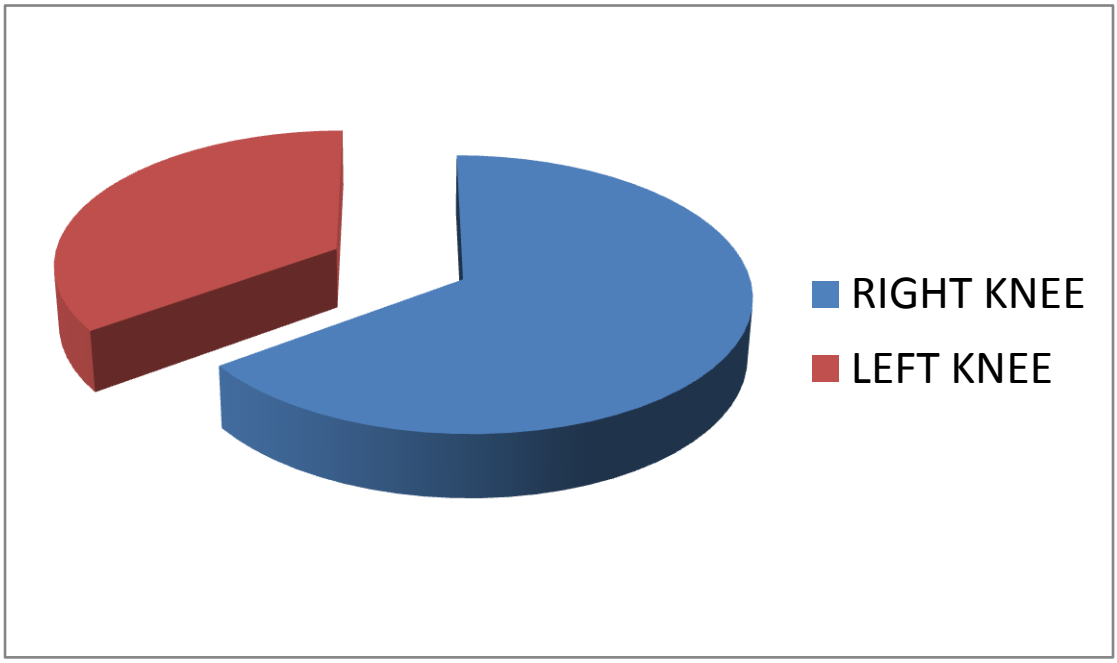


TABLE V

ASSOCIATED MENISCAL INJURIES IN 2 CASES

Meniscus injury	No. of cases	Percentage
Lateral	0	0
Medial	2	10%

Only two cases had associated meniscal tear and both were of medial meniscus.

TABLE VI

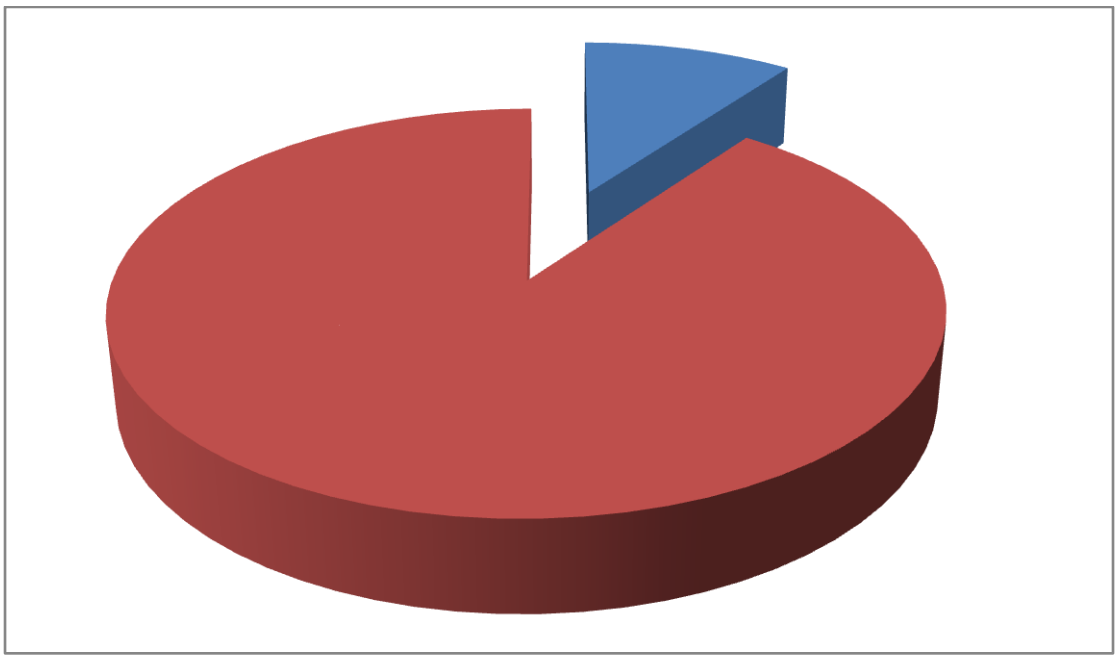
DURATION BETWEEN INJURY AND ACL RECONSTRUCTION

Duration in months	Number of cases
< 6 months	11
6 – 12 months	2
>12 months	7

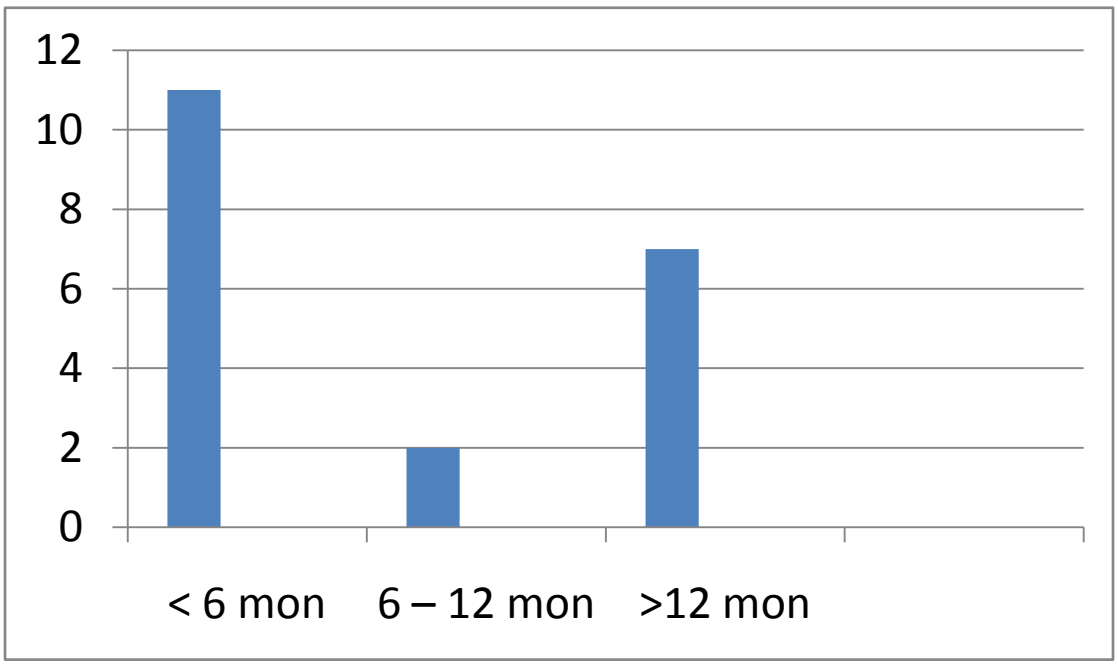
Our study also followed the protocol of open group as :

- ACL Reconstruction was done as early as 1 month post injury to as late as 72 months post injury.

ASSOCIATED MENISCAL INJURIES



DURATION BETWEEN INJURY AND ACL RECONSTRUCTION



- **INCLUSION CRITERIA**:
    - Patients with clinically Lachman test, anterior drawers test or MRI positive for ACL rupture were included in our study.
    - All cases with only anterior cruciate ligament injuries irrespective of the mode of injury/duration/mechanism of injury/associated injuries of menisci were included in our study.

- **EXCLUSION CRITERIA**:
    - Patients with bony ACL avulsion or other associated fractures were excluded from our study.
    - Cases with multiple ligament injuries of the knee, Cases with bilateral ACL injuries and revision ACL reconstructions were excluded from the study.

Round headed cutting interferential (RCI) screws/endo buttons were used for fixation.

Management

CLINICAL EVALUATION

Detailed history taking and clinical examination will aid in diagnosing IDK, especially ACL deficiency immensely. Histories regarding the actual chronology of events, aided with specific questions regarding mechanism of injury are assessed.

The methodical history includes:

1. Mode of violence.
2. Feeling of "pop" inside the knee during the initial injury.
3. Ability to weight bear/continue play after injury / fall.
4. Haemarthrosis – highly suggestive of ACL injury.
5. Nature of treatment like aspiration, duration of immobilization etc.,
6. History of instability - giving way during level walking or climbing stairs is the most common symptom (65%), according to **pattee et al**[34] .
7. History of pain in the knee is the second common symptom in about 61% of the patients.
8. Locking episodes- degree of locking, whether fixed/variable and the unlocking mechanism.

CLINICAL EXAMINATION

A thorough examination of the knee is done, which includes, inspection, palpation, and instability tests:

1) Lachman Test
2) Anterior drawer test
3) Pivot shift test
4) Valgus or Varus stress test
5) McMurray's test –to rule out associated meniscal injuries.

With a good history and examination, most of the time ACL injury can be diagnosed. **Sung-jae kim (1995) et al**[35], found in his study of proved ACL deficient patients examined under anesthesia to be positive for **anterior drawer test in 79.6%, lachman test in 98.6%** and **pivot shift test in 89.8%** of cases**.**

Denny t.t.lie(2007)et al[36]**,** showed persistence of pivot shift in reconstructed patients and reliability and usefulness of an in vivo pivot shift test in assessing kinematics of the knee after surgery regarding time-dependent changes be influenced by graft tension and the surrounding soft tissue healing.

LACHMAN TEST

The Lachman test can be useful even in an acute knee. The patient is placed supine on the examining table with the involved extremity to the examiners side. The involved extremity is positioned in slight external rotation and the knee between full extension and 15 degrees of flexion; the femur is stabilized with one hand, and firm pressure is applied to the posterior aspect of the proximal tibia, which is lifted forward in an attempt to translate it anteriorly. The position of the examiners hands is important in doing the test properly. One hand should firmly stabilize the femur while the other grips the proximal tibia in such a manner that the thumb is on the anteromedial joint margin. When the palm and the fingers apply an anteriorly directed lifting force, anterior translation of the tibia in relation to the femur can be palpated by the thumb. Anterior translation of the tibia associated with a soft or a mushy end point indicates a positive test.

ANTERIOR DRAWER TEST

Patient in supine position, hip flexed to 45° and knee in 90° flexion with foot placed on tabletop. The patient's foot is sat on to stabilize it and both hands are placed behind the knee to feel relaxation of the hamstrings. The proximal part of the leg is repeatedly pulled and pushed anteriorly and posteriorly noting the movement of tibia on

femur. The test is done in three positions of rotations as (i) Tibia in neutral, (ii) in 30° of external rotation and (iii) in 30° of internal rotation. The degree of displacement is each position of rotation is recorded and compared with the normal knee. Anterior Drawer's sign of 6 to 8 mm greater than the opposite knee indicates a torn ACL.

GRADING FOR ONE-PLANE INSTABILITY

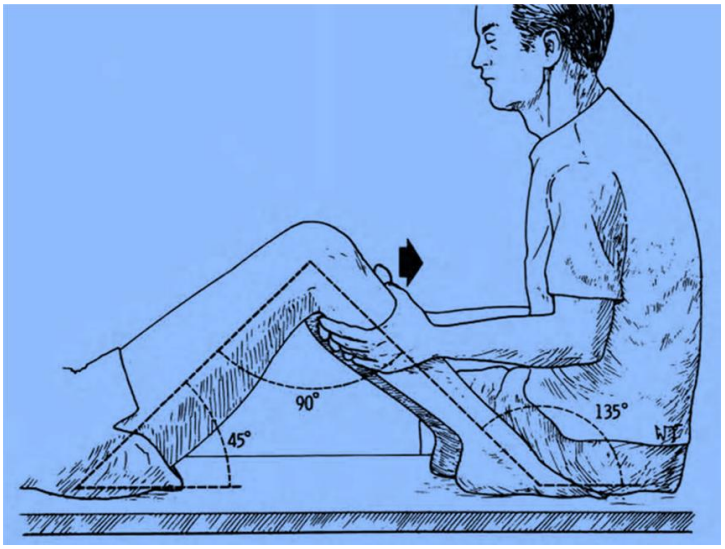
Grade	Translation in cms
O	Normal Laxity
1+	< .5 cm
2+	0.5 – 1 cm
3+	1 – 1.5 cm
4+	> 1.5 cm

PIVOT SHIFT TEST

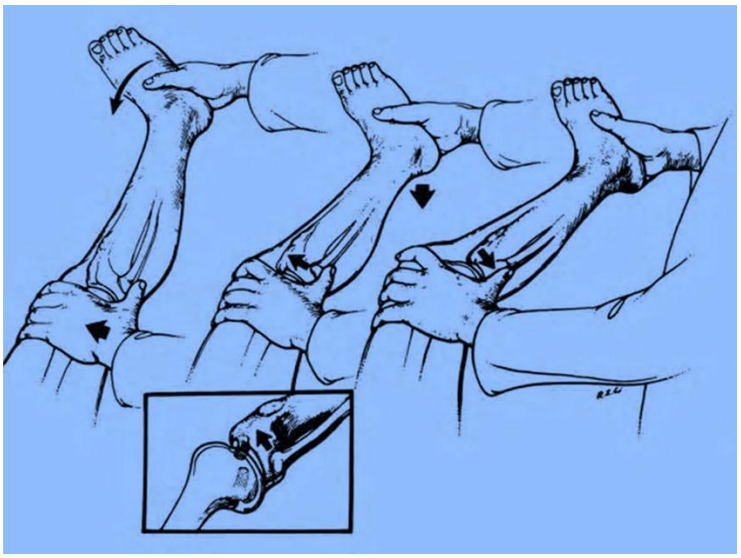
Seiji Kubo et al[37], found this clinically very useful and repetitive measurements give data regarding time dependent changes in knee kinematics. It is used to assess the "rotational" component of instability associated with an ACL injury. A positive test result is pathagnomonic of ACL deficiency. The test described by **Galway**

and associates, is based on the subluxation and reduction of the lateral compartment as the knee moves from extension to flexion in patients with an ACL deficient knee. With the knee in extension, the lateral tibial plateau subluxes anteriorly in relation to the lateral femur.A valgus stress is placed on the tibia, as the knee in slowly flexed. At approximately 30° of flexion, the lateral tibial plateau will reduce suddenly, and the abruptness of reduction is noted. The test result is grade O (normal) if no shift is present, grade1 if there is a smooth glide during reduction, grade 2 if the tibia is noted to "jump" back into the reduced position and grade 3 if there is a transient locking of the tibia in the subluxed position before reduction. The accuracy of the test is limited while the patient is awake because of guarding and muscle splinting but improves dramatically with the patient under anesthesia. Nogalski and bach noted a sensitivity of pivot shift test of only 24% while the patient was awake, which improved to 92% with the patient under anaesthesia, we consider the results of the pivot shift test with the patient under anaesthesia the most important diagnostic element in the assessment of the functional status of the native ACL or ACL graft.

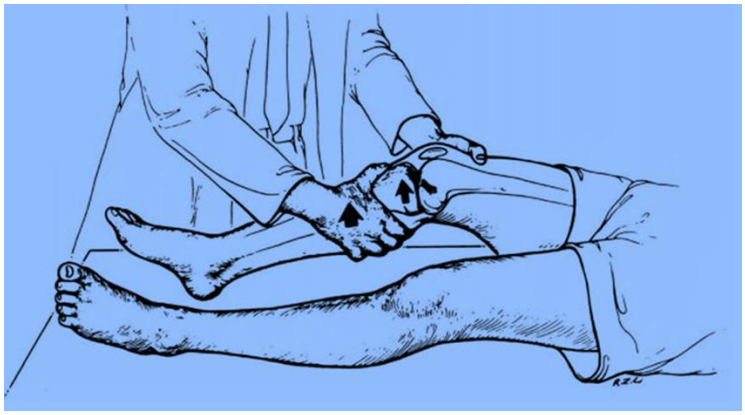
ANTERIOR DRAWER TEST



PIVOT SHIFT TEST



LACHMAN TEST



OTHER INVESTIGATIONS

1. **X-ray of the knee**: To rule out bony avulsions, associated osteochondral fractures, segond's fracture, etc. A true lateral view with the knee at 30◦of flexion, patella lies between the lines from physeal scar of distal femur and Blumenstaat's line (inter condylar roof) inferiorly and hence patella alta or baja can be determined.
2. **MRI of the knee** –Recent advances as with 3-D gradient enable visualization of early and chronic cartilage damage with direct signs.

   Sensitivity is about 92-94%

   Specificity is about 95-100%

Sagittal images are most useful in assessing ACL fiber orientation and both attachments. Coronal view shows ACL orientation as "hand in pocket". Axial view is useful in assessing ACL and PCL in the notch, bone contusion, Para articular fluid collection and joint capsule. MRI is not accurate in differentiating complete from partial tear or chronic tears.

NORMAL ACL APPEARANCE IN MRI

Taut with straight anterior margin in Sagittal view, with the knee **in extension**. With the knee flexed fibres are lax with a curved course. On a mid Sagittal view ACL is oriented nearly parallel to Blumensaat's line inclining about **55°** from the tibial plateau.

MRI APPEARANCE OF AN INJURED ACL

- Poor or non-visualization of the ACL on Sagittal image.
- Amorphous edematous mass with a focally increased signal on T_2 weighted image.
- Irregular contour with wavy redundant fibres.

INDIRECT SIGNS

- Posterior translation of femoral condyles relative to the posterior margin of the tibia of 7 mm or more.
- Abnormal orientation of fibres in intercondylar notch, failure to parallel its roof in mid Sagittal views.
- Buckling of PCL.

Meniscal injuries are present in 41% to 68% of ACL cases, more of medial meniscus.

Byoung hyun et al[38], found Oblique axial images to be more useful than coronal and Sagittal slices in evaluating the integrity of reconstructed ACL and sufficiency of Notchplasty to prevent impingement. **Takeshi kanamiya et al[39],** showed high intensity of ACL graft is caused by Impingement and not indicative of instability.

COUNSELLING

Forms the important part of our protocol, patients are instructed that surgery is to be perceived as a process and not an end event and there is a strict post op regime to be followed to get results.

PHYSIOTHERAPY

Quadriceps and Hamstring strengthening exercise are started, as soon as, the patient is diagnosed to have an ACL deficiency.

TYPES OF GRAFT FOR ACL RECONSTRUCTION

According to **Suzane l. miller**[40] (2002) An ideal graft for Anterior Cruciate ligament reconstruction should reproduce the complex anatomy of the ACL, provide the same biomechanical properties as the native ACL, permit strong and secure fixation, promote rapid biological incorporation and minimize donor site morbidity.

TYPES OF GRAFT

- Autograft
- Allograft

AUTOGRAFT

It is the graft taken from one's own body.

The Autografts Used For ACL Reconstruction are :

a. Bone patellar tendon bone graft (BPTB GRAFT)

b. Quadrupled semitendinosus / gracilis tendon graft

(HAMSTRING GRAFT)

c. Quadriceps tendon with or without proximal patellar bone plug

We used only quadrupled Hamstring tendon graft for all our cases in this study

	Ultimate Strength(N)	Stiffness(N/M)	Cross sec area(mm^2)
Intact ACL	2160	242	55
B-PT-B	2376	812	32
Quadruple Hamstring	4108	776	53
Quadriceps Tendon	2352	463	62
Tibialis anterior	3412	344	38
Tibialis Posterior	3391	302	48

THE HAMSTRING GRAFT

Pros:

- Minimal post-operative pain
- Easier rehabilitation
- Quicker return to Activities of Daily Living (ADL)

Cons:

- Fixation is not as strong initially
- Hamstring weakness
- Slower return to full athletic participation (9 months)

Operative technique

INSTRUMENTS AND EQUIPMENTS

1. ARTHROSCOPE

It is an optical instrument, which can transmit light. It consists of a rod –lens system surrounded by multiple lights conducting glass fibrils. Depending on the angle of inclination, which is the angle between the axis of the arthroscope and a line perpendicular to the surface of the lens, there are 3 types of arthroscopes as 30°, 70° and 90° arthroscopes.

2. FIBEROPTIC LIGHT SOURCE

It consist of a tungsten, halogen, or a xenon arc light source that generates 300 to 350 watts and the fiber optic cable consists of a bundle of specially prepared glass fibers encased in a protective sheath. One end of the fiber optic cable is attached to the light source and the other end to the arthroscope.

3. VIDEO CAMERA

It is a small, solid-state camera, which can be sterilized and connected directly to the arthroscope.

4. MONITOR

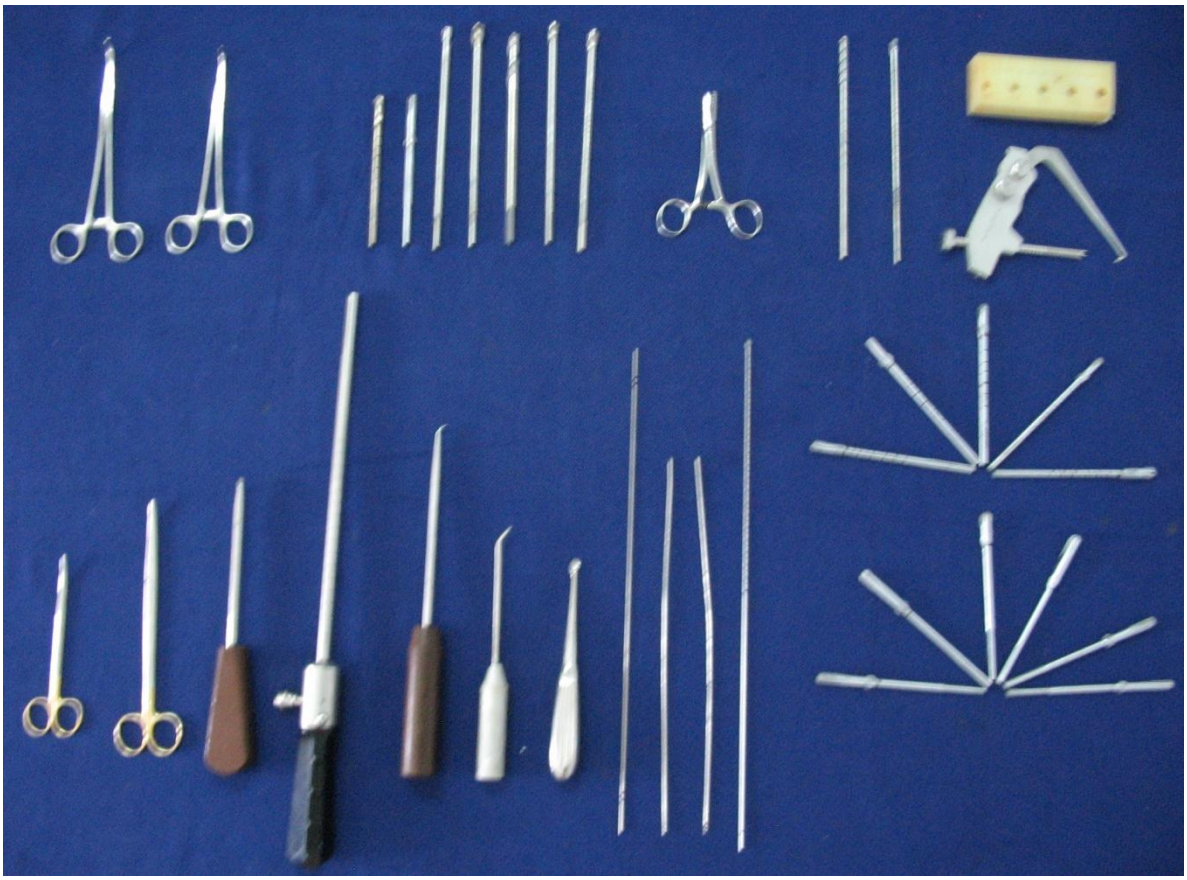
It is used to view the output from the camera and for recording.

5. BASIC ARTHROSCOPIC HAND INSTRUMENTS

a. The Probe

HAND INSTRUMENTS, CLOSED TENDON HARVESTOR AND

FLOWER TIPPED REAMERS



b. Arthroscopic basket forceps

c. Arthroscopic grasping forceps.

Hand instruments are sterilized by autoclaving technique. Cables and camera are sterilized in a formalin chamber.

PORTALS- Key to success

STANDARD PORTALS

1. Antero-lateral (AL)
2. Antero-medial (AM)
3. Postero-medial (PM)
4. Supero-lateral (SL)

OPTIONAL PORTALS

1. Posterolateral portal
2. Proximal midpatellar portal
3. Central transpatellar tendon portal

Once inside the knee the following compartments are viewed methodically.

1. Suprapatellar pouch and patellofemoral joint
2. Medial gutter
3. Medial compartment (the intercondylar notch) – ACL is visualized here.
4. Posteromedial compartment
5. Lateral compartment

6. Lateral gutter and posterolateral compartment

We confirm our diagnosis and deal with associated meniscal injuries with arthroscopy, before ACL reconstruction.

PRE OP ASSESSMENT

Careful assessment is critical to the success of the procedure. Appropriate time for surgery is when the patient had achieved pain free knee with a full range of motion along with appropriate physiotherapy, which would approximately take 2-3 weeks.

EXAMINATION UNDER ANAESTHESIA

Lachman, pivot shift along with a complete knee examination is done including valgus/ varus stress tests, and the anterior and posterior drawers are performed.

PROCEDURE

- Under spinal anaesthesia
- Under tourniquet control

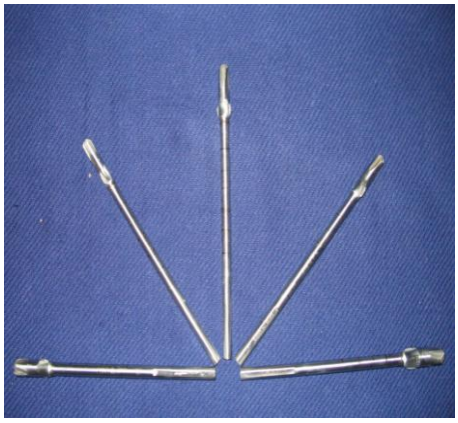
PATIENT POSITIONING

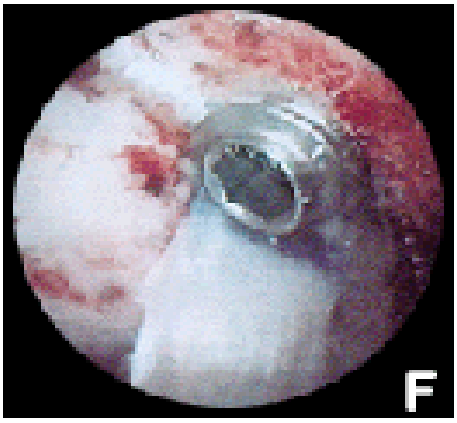
- Patient in supine position, with thigh and foot supports.

GRAFT HARVEST

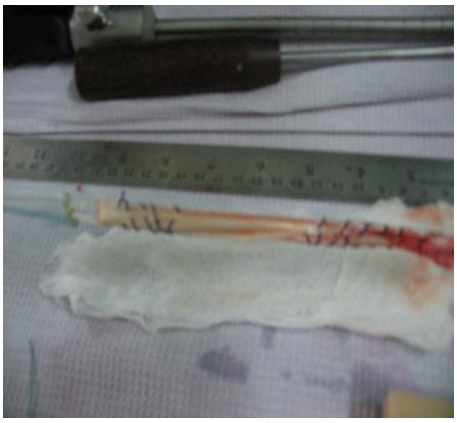
Gracilis and semitendinosus are harvested. A four strand Graft construct is prepared with whip stitch to the tibial end with the hamstring tendon still attached to the Tibia.

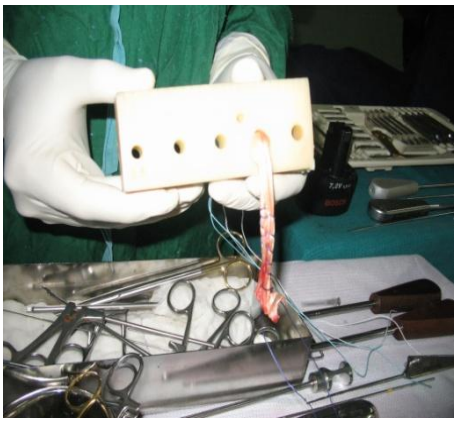
THE OPERATIVE TECHNIQUE

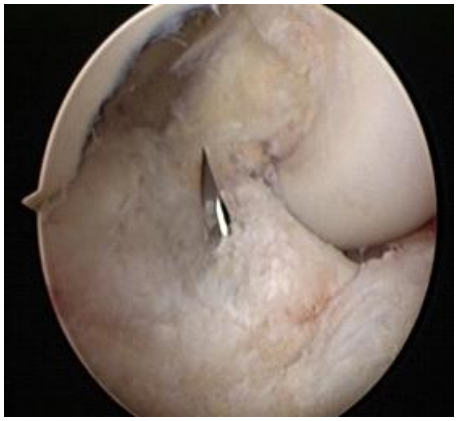


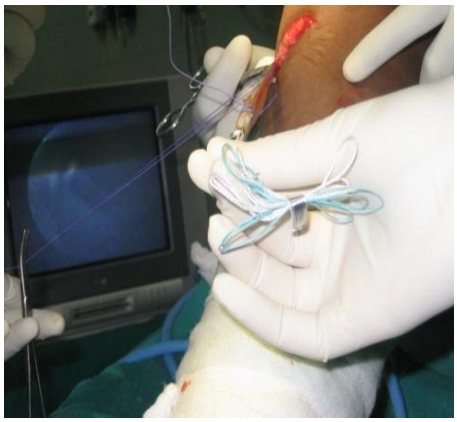


THE OPERATIVE TECHNIQUE-CONT.,



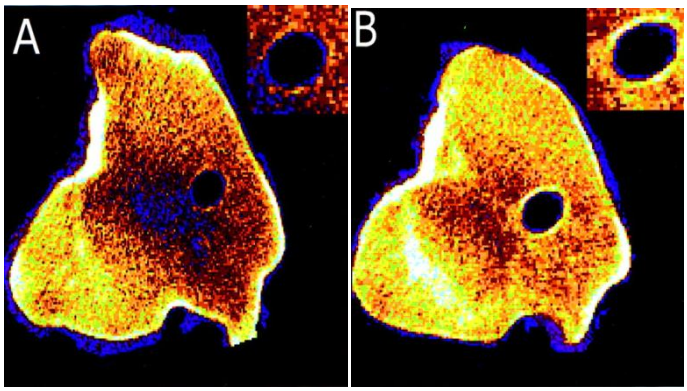






Drilling method-Extraction versus compaction Drilling* method-

PORCINE TIBIA-Extraction Versus compaction*



(* our method)

PORTALS

ANTERO LATERAL PORTAL

Through a stab incision made through the skin about 1 cm above the lateral joint line.

ANTERO MEDIAL PORTAL

This can always be made with an aid of an 18 –gauge spinal needle visualized arthroscopically for optimal placement and to avoid medial meniscus. We prefer tendon harvest before arthroscopy.

Routine Arthroscopy performed Meniscal Repair or Meniscectomy if any is done at this stage. Remaining ACL fibres are debrided and tibial foot print outline is left to help with tibial tunnel placement. Lateral wall and roof preparation done for intercondylar notch and is cleared off all debris.

FEMORAL TUNNEL

The femoral tunnel is made first at 9:30‘O clock/1:30‘O clock for right and left sides respectively through the medial portal with the knee in 120*of flexion. Femoral Aimer with 7° offset is used as the Tongue of it is positioned “Over the Top”. Knee may have to be extended slightly to get the tongue over the top. Guide wire is inserted through the aimer, flower top reamers are used over Guide wire and an

incomplete tunnel of about 25 mm depth is drilled. Step drilling for the femur is done in case of Endobutton.

TIBIAL TUNNEL PLACEMENT

The Tibial tunnel is made with the Director Guide –Elbow Aimer. ACL Tibial guide is inserted through the Antero medial portal and its tip placed on the tibial foot print of ACL.**Morgan et al**[42] showed center of ACL insertion about 7.1 mm to anterior edge of PCL at 90° of knee flexion. **Jackson and Gasser**[43] clinically confirmed sagittally a point 7 mm anterior to PCL anterior margin is ideal to avoid Graft- Roof impingement. The average angle of Tibial tunnel is 55° to tibial plateau in coronal plane. **Wolf peterson**[31] described the two land marks used for tibial tunnel placement in all arthroscopic technique as :

a) 7mm from the anterior margin of PCL INSERTION is found to be center of postero-lateral fibers

b) Anterior horn of lateral meniscus described to be center of antero-medial fibers.

ACL Tibial Guide is placed on upslope of tibial spine just lateral to edge of articular surface of medial tibial plateau; the angle of the guide is about 55°.Guide wire drilled under arthroscopic visualization.

GRAFT PASSAGE

Graft is sized with sizers. The appropriately sized graft is passed through a BEATH PIN (a long wire with an eye at one end). Always hyper flex the knee & exit the pin laterally. With knee back to about 80-90° of flexion, pull the graft into the knee, with the help of **probe** direct the leading graft into femoral tunnel with its cancellous surface facing anteriorly.

FEMORAL FIXATION

Is done by interference screw/endobutton through the antero medial portal, the knee is hyper flexed to allow parallel placement of screw to graft by an anti rotation guide wire and interference screw at anterior interface and this may be aided by "**Tunnel Notcher".**

The knee must be hyper flexed and an assistant should keep equal tension on both sides through sutures applied to the graft so that graft does not advance as the screw is inserted. The screw is inserted till it is flush with the end of the bone block. Look for impingement in full extension; lateral wall impingement is safely and easily addressed With a curette. The ideal placement of tunnel is in the foot print of the native ACL on femur which roughly corresponds to 9:30 'O clock for right knee and 1:30 'O clock position for left knee to minimize impingement.

TIBIAL FIXATION:

The knee is cycled through a full range of motion for about 20 times (**TENSIONING**). The knee is then brought to full extension, maximal manual tension applied to sutures of the graft appropriate sized interference screw applied at anterior interface of the graft with the knee placed in 20-30° of flexion for the initial purchase and in full extension as the screw advances.

Lachman test is performed and the complete range of movements assessed. Anteromedial periosteal flap is closed and the remaining wound closed in layers.

Rehabilitation

REHABILITATION AFTER ACL RECONSTRUCTION

'The Science Of ACL Rehabilitation' by **Bruce D.Beynnon et al**[44],(2002)describe that there is evidence based from R C T that immediate weight bearing after reconstruction of ACL is beneficial as it lowers patello femoral pain without increased anterior knee laxity and resulted in a better outcome in an endoscopicaly reconstructed ACL.

Feddric H.Fu et al's[45]**,** analysis of outcome in an endoscopicaly reconstructed ACL substantiates the fact that Early R O M, and controlled Endurance programmes highly improved outcome and **David Fischeretal**[46], observation of supervised home based Rehabilitation programme for arthroscopicaly reconstructed ACL substantiates its efficacy equivalent to clinic based one.

Rehabilitation after ACL (anterior cruciate ligament) reconstruction has drastically changed over the last decade, with the adoption of a more aggressive approach, right from the first day after surgery .The aggressive rehabilitation after ACL rehabilitation is possible because of improved operative techniques, and also there are encouraging results of histological studies regarding early graft healing following aggressive rehabilitation program.

The importance of range-of-motion exercises, early weight bearing, an appropriate gait scheme, patellar mobilization, pain and oedema control, as well as stretching and balance exercises are explained well to the patients.

PRE OPERATIVE PHASE-GOALS

- Diminish swelling, inflammation and pain
- Restore near normal ROM (extension at least)
- Educate patient for surgery

Apply ice for pain

OUR POST OP PROTOCOL:

No Knee immobilizer was used. The patient was encouraged to maintain extension as possible and continue static Quadriceps exercises. Patients were mobilized with full weight bearing with elbow crutches the next day and advised to use crutches for a week only. Strengthening exercises of the quadriceps femoris and the hamstrings were initiated after the 1st post-operative day. Closed chain kinetic exercises were initiated after the 1st post operative day and were continued for 12 weeks. Open chain exercises started after the 12th week. Return to sports allowed at the end of 9 months.

TREATMENT GOALS

IMMEDIATE POST OP:

1. Full knee extension
2. 90 deg knee flexion
3. Good Quadriceps setting
4. FWB with crutches

2 WEEKS UP TO 6 MONTHS:

1. Isometric Q exercises
2. Exercise bike
3. Roving exercises
4. ROM 0 to 120 deg
5. FWB without crutches

AFTER 6 MONTHS:

1. Plyometric shuttle program
2. Jump rope
3. Jogging program

END OF 9 MONTHS; Return to sports;

Criteria 1. Motion>130 deg

2. Hamstrings>90% of normal strength.
3. Quadriceps>85% of normal strength.

Maintenance exercises are recommended 2-3 times per week

Observations

OBSERVATIONS

In our study group of 20 cases of Arthroscopic ACL reconstruction:

- Majority of the patients (12 cases) were in the age group between 21-30 years - indicates that young and active people were most often involved.
- Males were injured more commonly than females.
- Sports injuries were the common cause of ACL injury closely followed by RTA.
- RIGHT knee was found to be affected more than LEFT.
- Medial meniscus injuries, were associated with only 2 CASES

Results

RESULTS

- The outcome of our study was assessed using the Lysholm knee scoring system and IKDC subjective knee evaluation score at the end of final follow up.
- **LYSHOLM KNEE SCALE**
- It is both a subjective and objective scoring system with the maximum score for each section as indicated below:

➢ Section 1	➢ limp	➢ 5 POINTS
➢ Section2	➢ support	➢ 5 POINTS
➢ Section 3	➢ pain	➢ 25 POINTS
➢ Section 4	➢ instability	➢ 25 POINTS
➢ Section 5	➢ locking	➢ 15 POINTS
➢ Section6	➢ swelling	➢ 10 POINTS
➢ Section7	➢ stair climbing	➢ 10 POINTS
➢ Section8	➢ squatting	➢ 5 POINTS

- Grading the Tegner Lysholm knee score:
- <65-poor
- 65-83-fair

- 84-90-good
- >90 excellent

Section 1-limp

None	Slight or periodical	Severe and constant
5 points	3 points	0 points

In our observation 12 out of 20 cases had no limp (60%), 7 patients had slight or periodical limp (35%), 1 case had severe and constant limp (5%).

Section2-support

None	5 points
Stick or crutch	2 points
Weight bearing impossible	0 points

In our observation none of the cases required support to walk.

Section 3-pain

None	25
Inconstant and slight during severe exertion	20

Marked during severe exertion	15
Marked on or after walking more than 2 km	10
Marked on or walking less than 2 km	5
Constant	0

In our study 6 cases had no pain (30%), 10 cases had inconstant and slight pain during severe exertion (50%), 1 case had pain marked during severe exertion 1 case had marked pain on or after walking more than 2 km (5%), 1 case had marked pain on walking for less than 2 km (5%) & 1 case had constant pain (5%).

Section 4-instability

Never giving way	25
Rarely during athletics or other severe exertion	20
Frequently during athletics or other severe exertion(or incapable of participation)	15
Occasionally in daily activities	10
Often in daily activities	5
Every step	0

In our study 18 cases had no giving way (90%), 2 cases rarely during athletic activities or other severe exertion (10%).

Section 5-locking

No locking and no catching sensations	15
Catching sensation but no locking	10
Locking occasionally	6
Frequently	2
Locked joint on examination	0

In our study 15 cases had no locking or catching sensations(75%),4 cases had catching sensation but no locking(20%) and 1 case had an occasionallocking episode(5%).

Section6-swelling

None	10
On severe exertion	6
On ordinary exertion	2
Constant	0

In our study 16 cases had no swelling (80%), 2 cases had swelling on severe exertion (10%) and 2 cases had constant swelling (10%).

Section7-stair climbing

No problems	10
Slightly impaired	6
One step at a time	2
Impossible	0

In our study 12 cases had no problems in stair climbing (60%), 5 cases had slightly impaired stair climbing (25%), 3 cases able to do one step at a time (15%).

Section8-squatting

No problems	5
Slightly impaired	4
Not beyond 90 *	1
Impossible	0

In our study 13 cases had no problems with squatting (65%), 5 cases with slightly impaired squatting (25%) and 2 cases not beyond 90 *(10%).

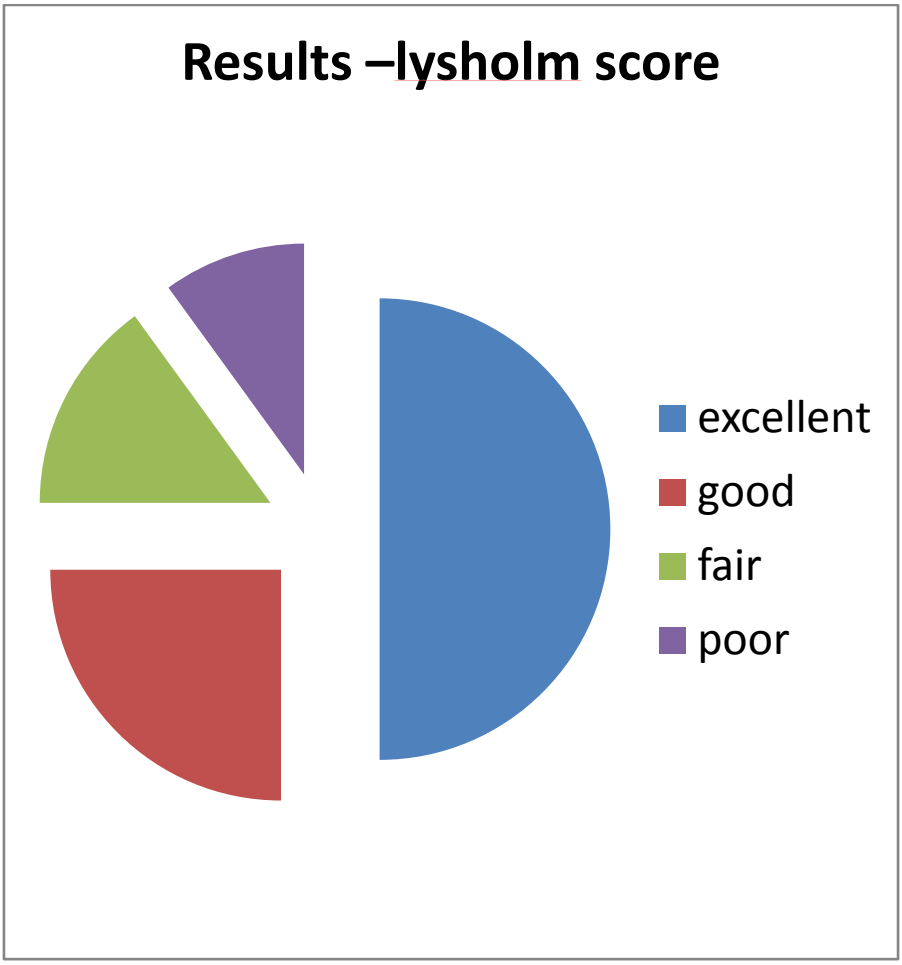
RESULTS

LYSHOLM SCALE

- 10 cases had excellent results(Lysholm scores-94,94,95,95,95,95,99,100,100,100)
- 5 cases had good results(Lysholm scores-86,89,90,90,90)
- 3 cases had fair results(Lysholm scores-71,73,79)
- 2 cases had poor results(Lysholm scores-59,63)

IKDC SUBJECTIVE KNEE EVALUATION SCORE

- Mean score=88.77
- Range from 74.7 to 98.9



PRE OP

MEAN SCORE-59

POST OP

MEAN SCORE-87.8

Case illustrations

CASE ILLUSTRATIONS

EXCELLENT RESULTS

CASE 1

NAME OF THE PATIENT : **Mr.L**

AGE/ SEX : **28/M**

IP: NO : **922814**

ASIC.NO :**240**

THE HISTORY : **2 yrs old injury/volley ball /right knee**

MECHANISM OF INJURY : **contact sports**

DATE OF SURGERY : **30/04/09**

ANTERIOR DRAWER TEST : **positive**

THE LACHMAN TEST : **positive**

PLC INJURY : **nil**

PIVOT SHIFT TEST : **positive**

OSTEOCHONDRAL DAMAGE ; **nil**

ASSOCIATED MENISCAL INJURY : **nil**

ACTIVITY LEVEL OF THE PATIENT: **Moderate**

FIXATION : **RCI Screw**

LYSHOLM SCORE : **PRE OP-79&POST OP-100**

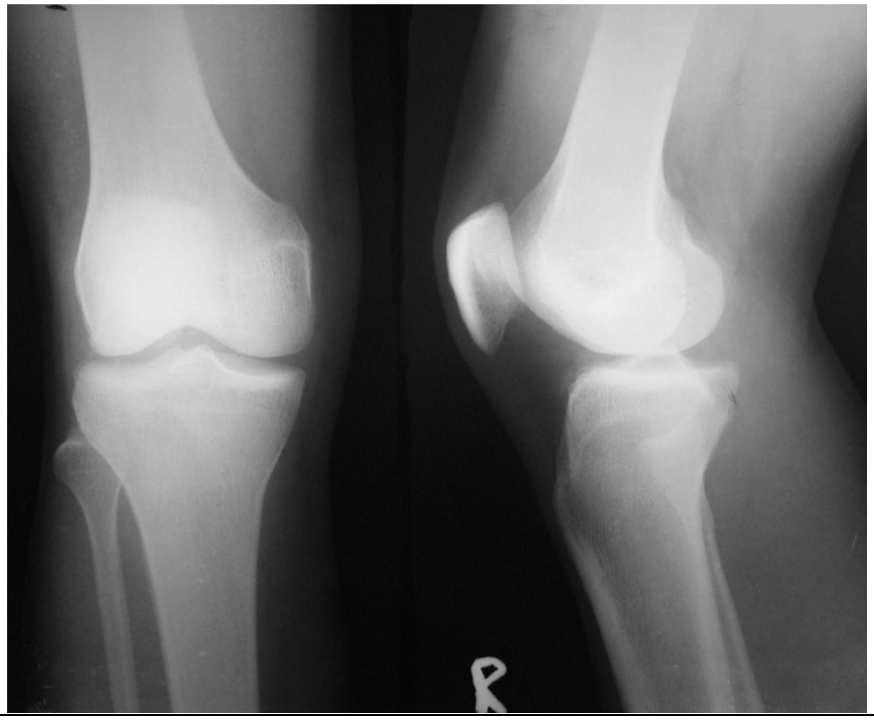
IKDC SCORE :**98.9**

CASE 1

CLINICAL PHOTOS

CASE 1

PRE OP X-RAYS



POST OP X RAYS

AP VIEW

LATERAL VIEW

CASE 2

NAME OF THE PATIENT : **Mr.S**

AGE/ SEX : **26/M**

IP: NO : **912360**

ASIC.NO :**151**

THE HISTORY : **2 months old injury/RTA /left knee**

MECHANISM OF INJURY : **RTA**

DATE OF SURGERY : **19/11/2008**

ANTERIOR DRAWER TEST : **positive**

THE LACHMAN TEST : **positive**

PLC INJURY : **nil**

PIVOT SHIFT TEST : **positive**

OSTEOCHONDRAL DAMAGE : **nil**

ASSOCIATED MENISCAL INJURY : **nil**

ACTIVITY LEVEL OF THE PATIENT: **Moderate**

FIXATION : **RCI Screw**

LYSHOLM SCORE : **PRE OP-67&POST OP-95**

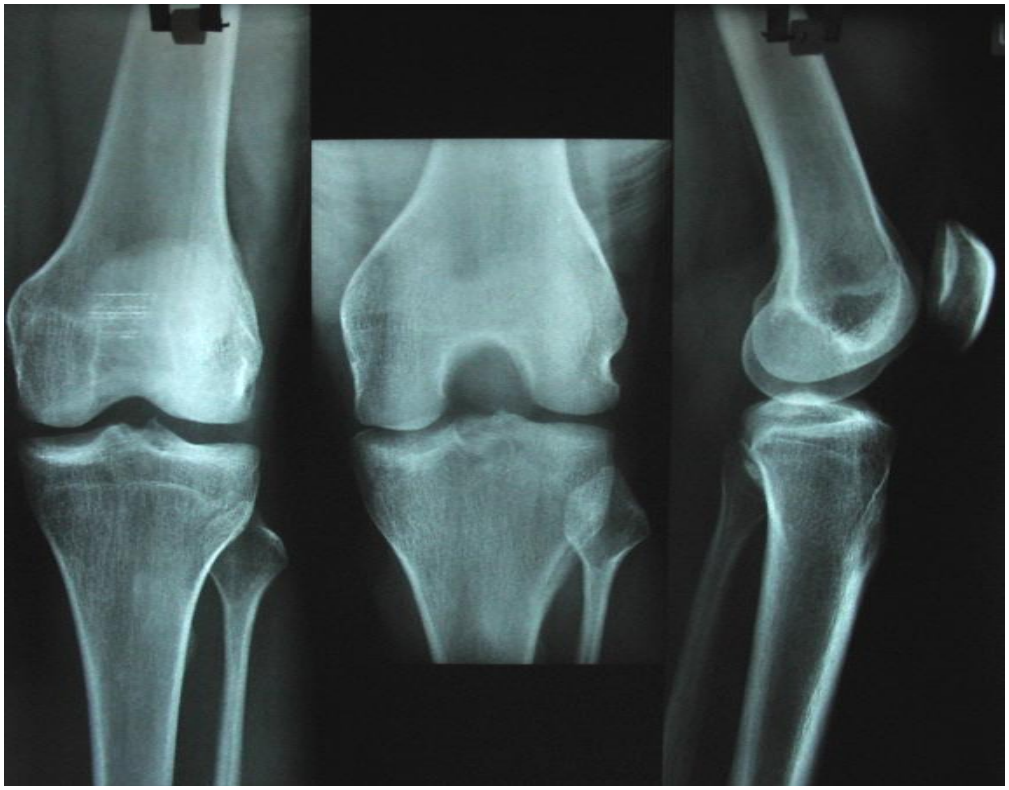
IKDC SCORE :**93.4**

CASE 2

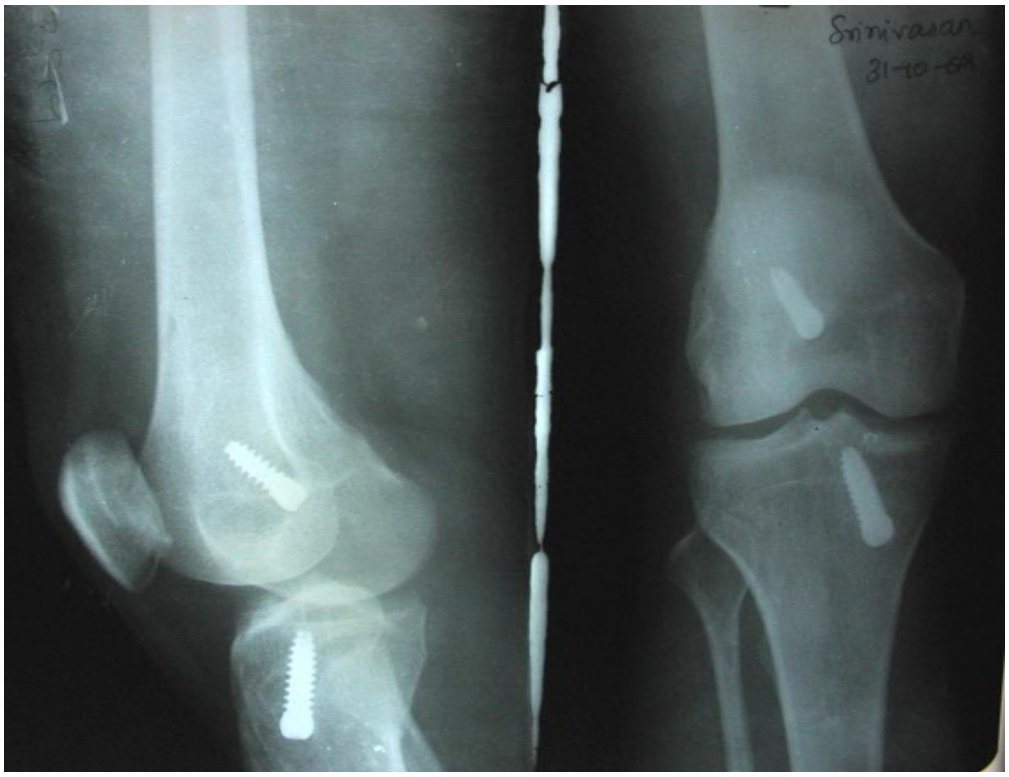
CLINICAL PHOTOS

CASE 2

RADIOGRAPHS-PRE OP



POST OP X RAY



GOOD RESULTS

CASE 3

NAME OF THE PATIENT : **Mr. R**

AGE/ SEX : **23/M**

IP: NO : **929353**

ASIC.NO :**301**

THE HISTORY : 4 **months /bull gore injury/ right knee**

MECHANISM OF INJURY : **Domestic**

DATE OF SURGERY : **30/07/2009.**

ANTERIOR DRAWER TEST : **Positive**

THE LACHMAN TEST : **Positive**

PLC INJURY : **Nil**

PIVOT SHIFT TEST : **Positive**

OSTEOCHONDRAL DAMAGE ; **mild /right femoral condyle**

ASSOCIATED MENISCAL INJURY : **Nil**

ACTIVITY LEVEL OF THE PATIENT: **Moderate**

FIXATION : **RCI screw**

LYSHOLM SCORE : **PRE OP-75 & POST OP- 90**

IKDC SCORE :**92**

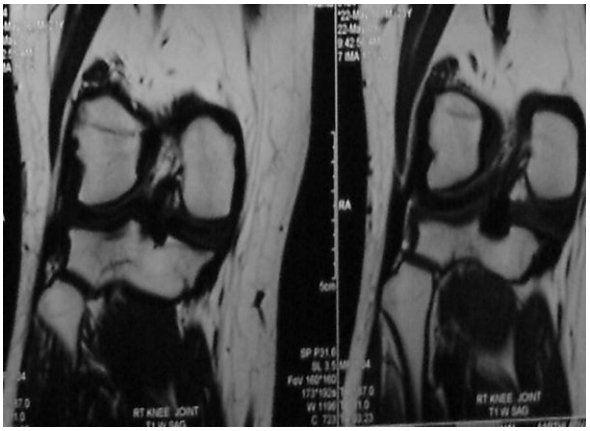
CASE 3

CLINICAL PHOTOS

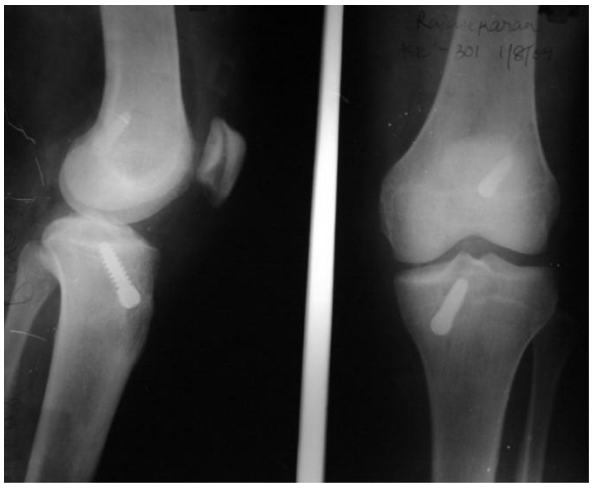
CASE 3

PRE OP MRI

CORONAL AND SAGITTAL VIEWS



POST OP RADIOGRAPH



CASE 4

NAME OF THE PATIENT : **MR.J**

AGE/ SEX : **32/M**

IP:NO :**918428**

ASIC :NO :**220**

THE HISTORY : **RTA/6 yrs back/right knee**

MECHANISM OF INJURY : **RTA**

DATE OF SURGERY : **26/02/2009**

ANTERIOR DRAWER TEST ; **Positive**

THE LACHMAN TEST : **Positive**

PLC INJURY : **Nil**

PIVOT SHIFT TEST : **Positive**

OSTEOCHONDRAL DAMAGE ; **Nil**

ASSOCIATED MENISCAL INJURY : **No**

ACTIVITY LEVEL OF THE PATIENT : **Mild**

FIXATION : **RCI Screw**

LYSHOLM SCORE : **PRE OP-67&POST OP-89**

IKDC SCORE :**85.9**

CASE 4-CLINICAL PHOTOS&X RAY (POST OP)

FAIR RESULTS

CASE 5

NAME OF THE PATIENT : **Mrs .P**

AGE/ SEX : **39/F**

IP: NO : **915829**

ASIC.NO : **131**

THE HISTORY : **Domestic injury/Dec2007/right knee**

MECHANISM OF INJURY : **Domestic**

DATE OF SURGERY : **13/01/2009**

ANTERIOR DRAWER TEST ; **Positive**

THE LACHMAN TEST : **Positive**

PLC INJURY : **Nil**

PIVOT SHIFT TEST : **Positive**

OSTEOCHONDRAL DAMAGE ; **Nil**

ASSOCIATED MENISCAL INJURY : **Nil**

ACTIVITY LEVEL OF THE PATIENT: **Mild**

FIXATION : **RCI Screw**

LYSHOLM SCORE : **PRE OP-9&POST OP -71**

IKDC SCORE :**75.9**

CASE 5

CLINICAL PHOTOS&X RAY (POST OP)

POOR RESULTS

CASE 6

NAME OF THE PATIENT : **Mr. M**

AGE / SEX : **28/M**

IP: NO :**935244**

ASIC.NO : **394**

THE HISTORY :**RTA/10.06.2009/right knee**

MECHANISM OF INJURY : **RTA**

DATE OF SURGERY : **22/10/2009**

ANTERIOR DRAWER TEST ; **Positive**

THE LACHMAN TEST : **Positive**

PLC INJURY : **Nil**

PIVOT SHIFT TEST : **Positive**

OSTEOCHONDRAL DAMAGE ; **Nil**

ASSOCIATED MENISCAL INJURY : **Nil**

ACTIVITY LEVEL OF THE PATIENT: **Moderate**

FIXATION : **Endobutton /RCI Screw**

LYSHOLM SCORE : **PRE OP-47&POST OP-63**

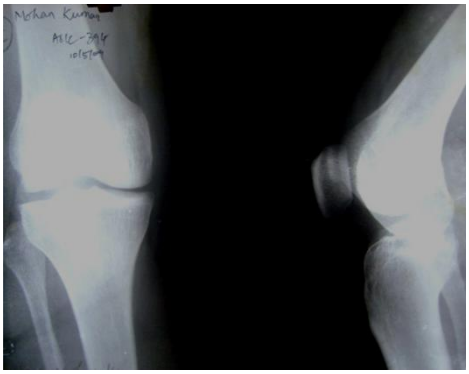
IKDC SCORE :**75.9**

CASE 6

CLINICAL PHOTOS

CASE 6-MRI SCAN

SAGITTAL VIEWS



PRE OP X RAY

POST OP X RAY

Complications

COMPLICATIONS

We had two of our cases (10%) with superficial wound infection which subsided with systemic intravenous antibiotics. However our study group is very small to comment about the actual incidence of complications using this technique. The complications which can occur using our technique includes screw pull out, tunnel widening ,graft failure, malpositioning of tunnel, …etc.,

Two of our cases who had poor results were non compliant to the post operative protocol and lost follow up early in the course of the study.

Discussion

DISCUSSION

Over the past several decades development in arthroscopic techniques and improvements in research have allowed ACL reconstruction to become one of the most successful techniques in sports medicine.

Our study of Arthroscopic ACL Reconstruction is preferred over open method as indicated in the scientific paper published by **"chir Narzadow Nuchu et al[47],** arthroscopic ACL reconstruction resulted in smaller amount of blood loss and better ROM at least during the first three months**.**

Our knee scoring system "the Lysholm Knee score" has been accepted as the standard scoring by various studies and the efficacy of its constituents are shown by **Boden moyar et al[48],** in their 26 months follow-up study showed patient's subjective rating are highly favorable and objective measure like pivot shift, ROM, thigh circumference and strength clearly favor arthroscopic ACL reconstruction than open method.

Since then ACL reconstruction has rapidly evolved into an arthroscopic procedure with an expectation to return to all activities at pre- injury levels of performance. This has occurred by technological advances in arthroscopy, improved arthroscopic skills and better understanding of knee biomechanics with revolutionized rehabilitation programs.

The graft is sized appropriately and fixed to the tunnel with an interference screw. This method of fixation has provided excellent initial fixation strength. We **tension** the graft by doing about 20 cyclical movements. **Yoshiiya** et al[49]**,** showed the effect of cyclical movements of passive flexion and extension produced a local elongation of the graft.

The use of the patellar bone tendon for the reconstruction of ACL has shown very good results[50]. The drawbacks that were noticed at the donor site led to the increase use of Hamstring tendon autografts. The hamstrings are more tolerant according to several biomechanical studies that have been well documented. This led to the extensive use of hamstrings tendons for ACL reconstruction during the last decade.

The hamstring autograft and rehabilitation protocol were the same for all patients. Out of 4 cases treated with endobutton 1 had good result, 2 with excellent results and 1 left with poor result. Endobutton did not seem to have any superiority of results when compared with usage of a standard titanium RCI screw. Out of 20 cases all of them had a soft end point in pre op lachman when compared to 18 cases with firm end point post op and 2 cases with delayed firm end point post op and none of them had a soft end point post operatively.

Two of our cases who had poor results were non compliant to the post operative protocol and lost follow up early in the course.

On Comparision of our study with other international publications, our results were found to be comparable:

	PRE OP LYSHOLM SCORE	POST OP LYSHOLM SCORE
OUR RESULTS	**59**	**87.8**
Apostolopoulos, a. Nakos, d. Nikolopoulos, f. Theofanopoulos, s. Liarokapis, i. Mihos Fourth Orthopaedic Department, General Hospital Askipiio, Voula, Greece	**49**	**88**
***The Journal of Bone and Joint Surgery (American)* 86:225-232 (2004) Anterior Cruciate Ligament Reconstruction with a Four-Strand Hamstring Tendon Autograft Riley J. Williams, III, MD[1], Jon Hyman, MD[2], Frank Petrigliano, MD[1], Tamara Rozental, MD[3] and Thomas L. Wickiewicz, MD[1]**	**55**	**91**

Statistical analysis

STATISTICAL ANALYSIS

Of the 20 patients who underwent surgery, all except one were males. All patients belonged to the economically productive age group (Mean age: 29.5, SD: 7.6). 50% of the patients (n=10) had suffered a sports injury which led to the ligament tear, while 40%(n=8) had suffered an RTA.

The mean time interval between the injury and undergoing the surgery was 13.4 months (SD: 17.7). This ranged between 1 month and 6 years in the group that underwent surgery.

Before the surgery, 11 of the patients (55%) had poor Lysholm grades (< 65), while only one was classified as good (> 83 to 90). No statistically significant relationships were noted between the pre-op grades and mode of injury ($p = 0.903$, χ^2 statistic = 0.205, Kruskaal Wallis test) and interval between injury and surgery ($p = 0.812$, χ^2 statistic =0.416, Kruskaal Wallis test).

Patients were followed up after a mean time interval of 14.6 months (SD: 4.9). The follow up period ranged between 4 months and 22 months. After the surgery, 50% (n=10) had excellent Lysholm grades (> 90), 25% (n = 5) had good grades (83 to 90) and only 2 patients had poor grades. The mean IKDC score was 88.8 (SD = 7.6) after the surgery.

MODE OF INJURY

PRE OP

Crosstab

		Preop Lysholm grading			
		Poor	Fair	Good	Total
Mode of injury	RTA	4	4	0	8
		50.0%	50.0%	.0%	100.0%
	Sports injury	6	3	1	10
		60.0%	30.0%	10.0%	100.0%
	Other injuries	1	1	0	2
		50.0%	50.0%	.0%	100.0%
Total		11	8	1	20
		55.0%	40.0%	5.0%	100.0%

POST OP

Crosstab

		Postop Lysholm grading				
		Poor	Fair	Good	Excellent	Total
Mode of injury	RTA	1	0	2	5	8
		12.5%	.0%	25.0%	62.5%	100.0%
	Sports injury	1	2	2	5	10
		10.0%	20.0%	20.0%	50.0%	100.0%
	Other injuries	0	1	1	0	2
		.0%	50.0%	50.0%	.0%	100.0%
Total		2	3	5	10	20
		10.0%	15.0%	25.0%	50.0%	100.0%

TIME BETWEEN INJURY AND SURGERY-CROSS TAB

PRE OP

Crosstab

		Preop Lysholm grading			
		Poor	Fair	Good	Total
Time betw een injury and surgery	less than 1 month	1	0	1	2
		50.0%	.0%	50.0%	100.0%
	betw een 1 month and 1 year	7	5	0	12
		58.3%	41.7%	.0%	100.0%
	After 1 year	3	3	0	6
		50.0%	50.0%	.0%	100.0%
Total		11	8	1	20
		55.0%	40.0%	5.0%	100.0%

POST OP

Crosstab

		Postop Lysholm grading				
		Poor	Fair	Good	Excellent	Total
Time betw een injury and surgery	less than 1 month	0	0	0	2	2
		.0%	.0%	.0%	100.0%	100.0%
	betw een 1 month and 1 year	2	1	4	5	12
		16.7%	8.3%	33.3%	41.7%	100.0%
	After 1 year	0	2	1	3	6
		.0%	33.3%	16.7%	50.0%	100.0%
Total		2	3	5	10	20
		10.0%	15.0%	25.0%	50.0%	100.0%

RESULTS-CROSS TAB

Preop Lysholm grading

	Frequency	Percent
Poor	11	55.0
Fair	8	40.0
Good	1	5.0
Total	20	100.0

Postop Lysholm grading

	Frequency	Percent
Poor	2	10.0
Fair	3	15.0
Good	5	25.0
Excellent	10	50.0
Total	20	100.0

Preop Lysholm grading * Postop Lysholm grading Crosstabulation

		Postop Lysholm grading				
		Poor	Fair	Good	Excellent	Total
Preop Lysholm grading	Poor	2	2	2	5	11
		18.2%	18.2%	18.2%	45.5%	100.0%
	Fair	0	1	3	4	8
		.0%	12.5%	37.5%	50.0%	100.0%
	Good	0	0	0	1	1
		.0%	.0%	.0%	100.0%	100.0%
Total		2	3	5	10	20
		10.0%	15.0%	25.0%	50.0%	100.0%

Coefficients[a]

Model		B	Sig.
1	(Constant)	49.281	.012
	Preop score	.417	.018
	Duration from injury to surgery in months	-.039	.803
	Age of patient	.490	.222

a. Dependent Variable: Lysholm score

Coefficients[a]

Model		B	Sig.
1	(Constant)	71.769	.000
	Preop score	.294	.003
	Duration from injury to surgery in months	-.063	.445
	Age of patient	.017	.934

a. Dependent Variable: IKDC

No statistically significant relationships were noted between the post-op grades and mode of injury ($p = 0.501$, χ^2 statistic = 1.384, Kruskaal Wallis test) and interval between injury and surgery ($p = 0.161$,

χ^2 statistic = 3.652, Kruskaal Wallis test).The post-op and pre-op Lysholm scores were found to have a moderately strong positive correlation (Pearson's r = 0.48, p = 0.031), while IKDC and pre-op scores also had a moderately strong positive correlation (Pearson's r = 0.69, p = 0.031).

Of the 11 patients who had a poor pre-op Lysholm score, only 2 had reported poor scores after the surgery (18.2%) while 5 reported as excellent (45.5%). Eight patients had reported fair Lysholm scores before surgery and 4 of them (50%) had excellent scores after the surgery while 3 (37.5%) reported good scores. This pattern of transformation in pre-op and post-op scores was found to be statistically significant ($p < 0.001$, χ^2 statistic < 0.005, Friedman test).

In a linear regression model incorporating age of the patient, time interval between injury and surgery and the pre-op Lysholm score as the predictors and post-op Lysholm score as the dependent variable, only the pre-op scores had a statistically significant relationship (B= 0.417, p=0.018). For every 1 point increase in the pre-op score, This model explained about 30% of the variability in the post-op scores. A similar relationship was found between pre-op Lysholm score and IKDC score was found in a linear regression model with the same predictors (B = 0.294, p = 0.003).

Conclusion

CONCLUSION

- ✓ ACL reconstruction by using four strand hamstring tendon autograft is highly successful in providing a stable knee with very few complications when proper graft, harvest preparation and **anatomical tunnel placement** is achieved.

- ✓ Endobutton did not seem to have any superiority of results when compared with the usage of a standard titanium RCI screw.

- ✓ Compaction drilling method when compared to extraction drilling is more advantageous.

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Annexure

Kruskal-Wallis Test –

The Kruskal-Wallis test is a nonparametric (distribution free) test, which is used to compare three or more groups of sample data. Kruskal-Wallis Test is used when assumptions of ANOVA are not met. In Kruskal-Wallis Test, we do not assume any assumption about the distribution. So Kruskal-Wallis Test is a distribution free test. If normality assumptions are met, then the Kruskal-Wallis Test is not as powerful as ANOVA.

Procedure for Kruskal-Wallis Test:

1. Arrange the data of both samples in a single series in ascending order.

2. Assign rank to them in ascending order. In the case of a repeated value, assign ranks to them by averaging their rank position.

3. Once this is complete, ranks or the different samples are separated and summed up as R_1 R_2 R_3, etc.

4. To calculate the value of Kruskal-Wallis Test, apply the following formula:

$$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{R_i^2}{} - 3(n+1)$$

Where,

H = Kruskal-Wallis Test

n = total number of observations in all samples

R_i = Rank of the sample

Crosstab, or Cross Tabulation, is a process or function that combines and/or summarizes data from one or more sources into a concise format for analysis or reporting. Crosstabs display the joint distribution of two or more variables and they are usually represented in the form of a contingency table in a matrix.

Cross Tabulations are popular choices for statistical reporting because they are very easy to understand and they are laid out in a clear format. They can be used with any level of data whether the data is ordinal, nominal, interval or ratio because the Crosstab will treat all of them as if they are nominal data. Crosstab tables are provide more detailed insights to a single statistics in a simple way and they solve the problem of empty or sparse cells.

The Lambda Coefficient is a method of testing the strength of association of Crosstabs when the variables are measured at nominal level.

The **Friedman Test** in the significance tests for more than two dependent samples is also known as the Friedman two way analysis of variance. The Friedman Test in the significance tests for more than two dependent

samples is used to test the null hypothesis. In other words, it is used to test that there is no significant difference between the size of 'k' dependent samples and the population from which these have been drawn. The Friedman test statistic in the significance tests for more than two dependent samples is given by the formulae:

$\text{Chi-square}_{\text{Friedman}} = ([12/nk(k + 1)]*[\text{SUM}(T_i^2] - 3n(k + 1))$

Pearson's correlation coefficient between two variables is defined as the covariance of the two variables divided by the product of theirstandard deviations:

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y} = \frac{E[(X - \mu_X)(Y - \mu_Y)]}{\sigma_X \sigma_Y},$$

The above formula defines the *population* correlation coefficient, commonly represented by the Greek letter ρ (rho).

Interpretation

The correlation coefficient ranges from −1 to 1. A value of 1 implies that a linear equation describes the relationship between X and Y perfectly, with all data points lying on a line for which Y increases as X increases. A value of −1 implies that all data points lie on a line for which Y decreases as X increases. A value of 0 implies that there is no linear correlation between the variables.

More generally, note that $(X_i - X)(Y_i - Y)$ is positive if and only if X_i and Y_i lie on the same side of their respective means. Thus the correlation coefficient is positive if X_i and Y_i tend to be simultaneously greater than, or simultaneously less than, their respective means. The correlation coefficient is negative if X_i and Y_i tend to lie on opposite sides of their respective means.

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

SYMPTOMS*:

*Grade symptoms at the highest activity level at which you think you could function without significant symptoms, even if you are not actually performing activities at this level.

1. What is the highest level of activity that you can perform without significant knee pain?

4❑Very strenuous activities like jumping or pivoting as in basketball or soccer

3❑Strenuous activities like heavy physical work, skiing or tennis

2❑Moderate activities like moderate physical work, running or jogging

1❑Light activities like walking, housework or yard work

0❑Unable to perform any of the above activities due to knee pain

2. During the past 4 weeks, or since your injury, how often have you had pain?

	10	9	8	7	6	5	4	3	2	1	0
Never	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑ Constant

3. If you have pain, how severe is it?

10	9	8	7	6	5	4	3	2	1	0
❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑
No pain									worst pain imaginable	

4. During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

4❑Not at all

3❑Mildly

2❑Moderately

1❑Very

0❑Extremely

5. What is the highest level of activity you can perform without significant swelling in your knee?

4❑Very strenuous activities like jumping or pivoting as in basketball or soccer

3❑Strenuous activities like heavy physical work, skiing or tennis

2❑Moderate activities like moderate physical work, running or jogging

1❑Light activities like walking, housework, or yard work

0❑Unable to perform any of the above activities due to knee swelling

6. During the <u>past 4 weeks</u>, or since your injury, did your knee lock or catch?

0❑Yes 1❑No

7. What is the highest level of activity you can perform without significant giving way in your knee?

4❑Very strenuous activities like jumping or pivoting as in basketball or soccer

3❑Strenuous activities like heavy physical work, skiing or tennis

2❑Moderate activities like moderate physical work, running or jogging

1❑Light activities like walking, housework or yard work

0❑Unable to perform any of the above activities due to giving way of the knee

<u>SPORTS ACTIVITIES</u>:

8. What is the highest level of activity you can participate in on a regular basis?

4❑Very strenuous activities like jumping or pivoting as in basketball or soccer

3❑Strenuous activities like heavy physical work, skiing or tennis

2❑Moderate activities like moderate physical work, running or jogging

1❑Light activities like walking, housework or yard work

0❑Unable to perform any of the above activities due to knee

9. How does your knee affect your ability to:

		Not difficult at all	Minimally difficult	Moderately Difficult	Extremely difficult	Unable to do
a.	Go up stairs	4❑	3❑	2❑	1❑	0❑
b.	Go down stairs	4❑	3❑	2❑	1❑	0❑
c.	Kneel on the front of your knee	4❑	3❑	2❑	1❑	0❑
d.	Squat	4❑	3❑	2❑	1❑	0❑
e.	Sit with your knee bent	4❑	3❑	2❑	1❑	0❑
f.	Rise from a chair	4❑	3❑	2❑	1❑	0❑
g.	Run straight ahead	4❑	3❑	2❑	1❑	0❑
h.	Jump and land on your involved leg	4❑	3❑	2❑	1❑	0❑
i.	Stop and start quickly	4❑	3❑	2❑	1❑	0❑

FUNCTION:

10. How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

FUNCTION PRIOR TO YOUR KNEE INJURY:

0 1 2 3 4 5 6 7 8 9 10

❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑

Couldn't perform daily activities — No limitation in daily activities

CURRENT FUNCTION OF YOUR KNEE:

0 1 2 3 4 5 6 7 8 9 10

❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑ ❑

Scoring Instructions for the 2000 IKDC Subjective Knee Evaluation Form:

Several methods of scoring the IKDC Subjective Knee Evaluation Form were investigated. The results indicated that summing the scores for each item performed as well as more sophisticated scoring methods.

The responses to each item are scored using an ordinal method such that a score of 0 is given to responses that represent the lowest level of function or highest level of symptoms. For example, item 1, which is related to the highest level of activity without significant pain is scored by assigning a score of 0 to the response "Unable to perform any of the above activities due to knee pain" and a score of 4 to the response "Very strenuous activities like jumping or pivoting as in basketball or soccer". For item 2, which is related to the frequency of pain over the past 4 weeks, the response "Constant" is assigned a score of 0 and "Never" is assigned a score of 10. **Note**: previous versions of the form had a minimum item score of 1 (for example, ranging from 1 to 11). In the most recent version, all items now have a minimum score of 0 (for example, 0 to 10). To score these prior versions, you would need to transform each item to the scaling for the current version.

The IKDC Subjective Knee Evaluation Form is scored by summing the scores for the individual items and then transforming the

score to a scale that ranges from 0 to 100. **Note**: The response to item 10a "Function Prior to Knee Injury" is not included in the overall score. To score the current form of the IKDC, simply add the score for each item (the small number by each item checked) and divide by the maximum possible score which is 87:

$$\text{IKDC Score} = \left[\frac{\text{Sum of Items}}{\text{Maximum Possible Score}} \right] \text{x } 100$$

PROFORMA

NAME OF THE PATIENT :

AGE/ SEX:

IP: NO:

ASIC.NO:

THE HISTORY:

MECHANISM OF INJURY:

DATE OF SURGERY:

ANTERIOR DRAWER TEST;

THE LACHMAN TEST:

PLC INJURY:

PIVOT SHIFT TEST:

OSTEOCHONDRAL DAMAGE;

ASSOCIATED MENISCAL INJURY:

ACTIVITY LEVEL OF THE PATIENT:

FIXATION:

LYSHOLM SCORE: PRE OP&POST OP

IKDC SCORE:

TEGNER LYSHOLM KNEE SCORING SYSTEM

During the past 4 weeks……

Section 1-limp	None	Slight or periodical	Severe and constant			
Section2-support	None	Stick or crutch	Weight bearing impossible			
Section 3-pain	None	Inconstant and slight during severe exertion	Marked during severe exertion	Marked on or after walking more than 2 km	Marked on or walking less than 2 km	Constant
Section 4-instability	Never giving way	Rarely during athletics or other severe exertion	Frequently during athletics or other severe exertion(or incapable of participation)	Occasionally in daily activities	Often in daily activities	Every step
Section 5-locking	No locking and no catching sensations	Catching sensation but no locking	Locking occasionally	Frequently	Locked joint on examinatio n	
Section6-swelling	None	On severe exertion	On ordinary exertion	Constant		
Section7-stair climbing	No problems	Slightly impaired	One step at a time	Impossible		
Section8-squatting	No problems	Slightly impaired	Not beyond 90 *	impossible		

Grading thetegner lysholm knee score:

<65-poor

65-83-fair

84-90-good

>90 excellent

MASTER CHART

S.NO	NAME	AGE/SEX	IP NO	ASIC NO	DATE OF INJURY	DATE OF ADMISSION	DATE OF SURGERY	MODE OF INJURY
1	Jesukumar	38/m	916378	128	July 08	21-01-09	22-01-09	RTA
2	Poongavanam	39/f	915829	131	Dec'07	12/01/09	13/01/09	Domestic
3	Gnanasekaran	25/m	927549	143	Feb 06	1/7/09	2/7/09	RTA
4	srinivasan	26/m	912360	151	Apr 08	19/11/08	20/11/08	RTA
5	Perumal	38/m	916174	152	2007	19/01/09	20/01/09	Cricket
6	Ramanathan	47/m	916686	185	July,08	26/01/09	27/01/09	Kabadi
7	Praveen kumar	24/m	918324	207	Feb 08	18/02/09	19/02/09	Foot ball
8	John	32/m	918428	220	2003	25/02/09	26/02/09	RTA
9	Dharmaraj	30/m	919981	226	Sep'08	16/03/09	17/03/09	Kabadi
10	Loganathan	28/m	922814	240	Apr 07	29/04/09	30/04/09	Volley ball
11	Bala subramaniam	25/m	923744	246	Mar '09	13/05/09	14/05/09	Kabadi
12	Meganathan	36/m	923678	261	May 07	11/05/09	12/05/09	Weight lifting
13	Rajasekaran	23/m	929353	301	21/03/09	29/07/09	30/07/09	Bull gore
14	Veeravel	38/m	931765	319	Apr 09	2/9/09	3/09/09	RTA
15	Arunachalam	21/m	930609	365	Feb 09	17/8/09	21/8/09	Slip local festival
16	Raj kumar(endo button)	22/m	978859	372	10/02/09	22/02/09	23/02/09	RTA
17	Baba narendiran(endobutton)	29/m	913615	387	2/5/09	31/08/09	1/9/09	Tennis
18	Mohan kumar(endobutton)	28/m	935244	394	10/6/09, 23/8/09	21/10/09	22/10/09	RTA
19	Karthik(endobutton)	22/m	933354	405	23/8/09	21/09/09	22/09/09	Cricket
20	Prakash	19/m	935099	418	Sep 09	14/10/09	15/10/09	RTA
	mean	29						
	median	28						
	Range	19-47						

RTA = ROAD TRAFFIC ACCIDENT
ASIC = ARTHROSCOPY & SPORTS INJURY CLINIC

MASTER CHART

S.NO	NAME	IP NO	INJURY TO SURGERY	FU in mon	AI	Pre op LYSHOLM SCORE	Post op LYSHOLM SCORE	R	C	IKDC SUBJECTIVE SCORE
1	Jesukumar	916378	6 mon	19	-	44	94	E	-	82.8
2	Poongavanam	915829	13 mon	19	-	9	71	F	-	75.9
3	Gnanasekaran	927549	42 mon	13	-	63	94	E	-	92
4	srinivasan	912360	7 mon	22	-	67	95	E	-	93.4
5	Perumal	916174	24 mon	19	MM	44	95	E	-	86.2
6	Ramanathan	916686	8 mon	19	-	47	90	G	I	86.2
7	Praveen kumar	918324	12 mon	18	-	63	73	F	-	82.8
8	John	918428	72 mon	18	-	67	89	G	-	85.9
9	Dharmaraj	919981	6 mon	17	-	53	86	G	-	87.4
10	Loganathan	922814	24 mon	16	-	79	100	E	-	98.9
11	Bala subramaniam	923744	2 mon	15	-	53	95	E	-	98.9
12	Meganathan	923678	24 mon	15	-	67	79	F	I	86.2
13	Rajasekaran	929353	4 mon	13	-	75	90	G	-	92.0
14	Veeravel	931765	5 mon	11	-	67	100	E	-	94.3
15	Arunachalam	930609	6 mon	5	-	44	59	P	-	74.7
16	Raj kumar	978859	2 mon	18	-	79	90	G	-	93.4
17	Baba narendiran	913615	4 mon	11	-	75	95	E	-	95.4
18	Mohan kumar	935244	4 mon	4	MM	47	63	P	-	75.9
19	Karthik	933354	1 mon	11	-	90	100	E	-	97.7
20	Prakash	935099	1 mon	10	-	47	99	E	-	95.4
	mean		13.35	14.6 mon		59	87.85			88.77
	median		6	15 mon		63	92			89.7
	Range		1 -72	4-22 mon		9-90	59-100			74.7-98.9

FU = follow u p ;AI = associated injurie; MM = medial meniscus; R=RESULT; E=excellent ;G=good; F=fair ;P=poor; C=COMPLICATIONS; I=infection